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US Army Corps of Engineers
Waterways Experiment Station

A User's Guide for Creating Risk-Based Mobility Products in CAMMS-D

by J. L. Williamson, N. C. Deliman

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Prepared for Headquarters, U.S. Army Corps of Engineers

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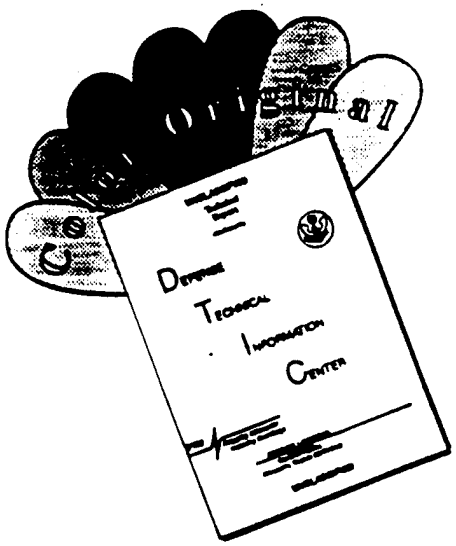

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by J. L. Williamson, N. C. Deliman

U.S. Army Corps of Engineers
Waterways Experiment Station
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

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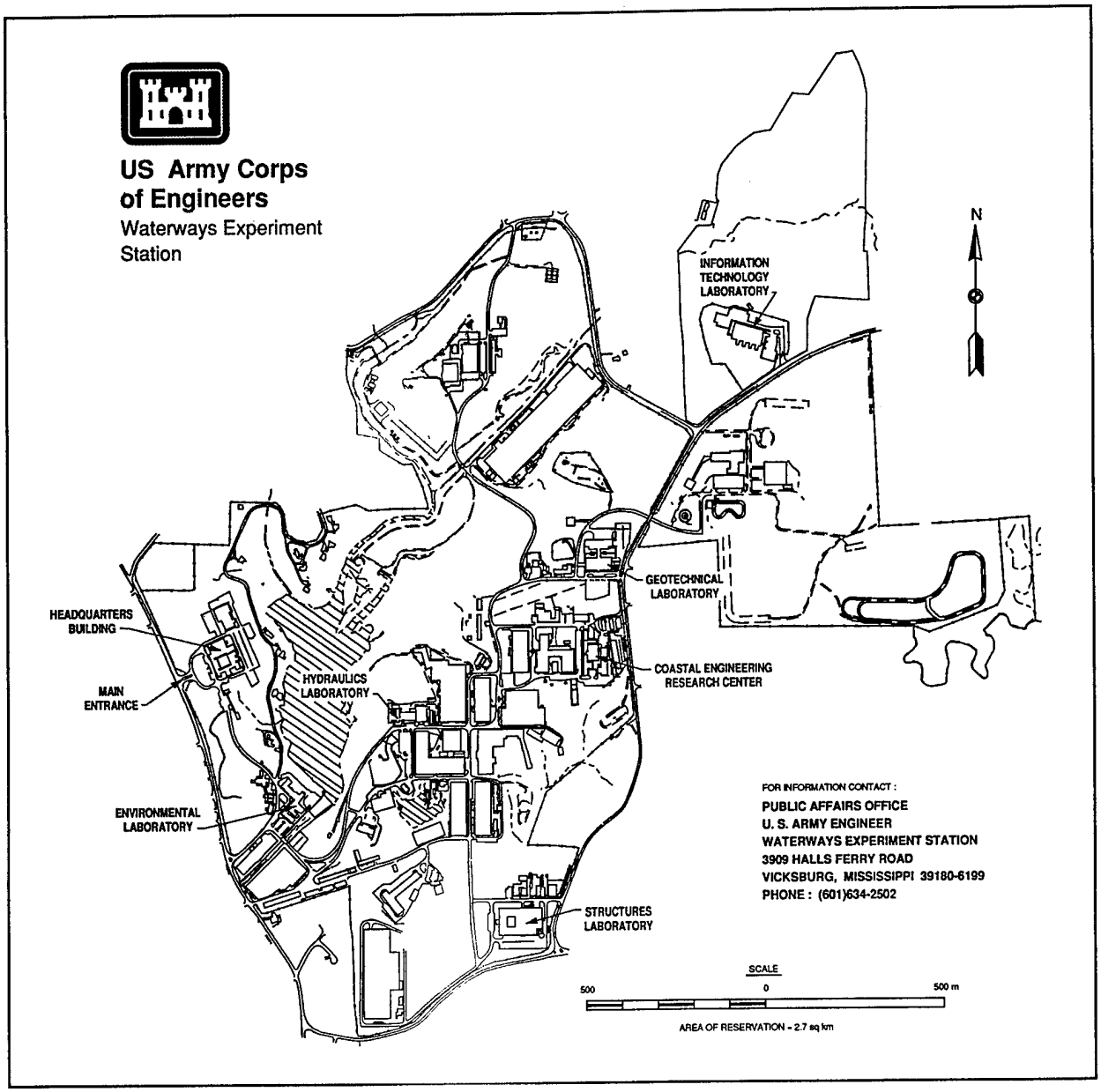

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Preface

Personnel of the U. S. Army Engineer Waterways Experiment Station (WES) conducted this study during the period October 1994 through July 1995 under RDTE Work Unit No. AT40-AM-013 entitled "Development and Evaluation of User-Oriented Stochastic Mobility Software."

The study was conducted under the general supervision of Dr. William F. Marcuson III, Director, Geotechnical Laboratory (GL), Mr. Newell R. Murphy, Jr., Chief, Mobility Systems Division (MSD), and Mr. Richard H. Gillespie, Chief, Analytical and Experimental Investigations Branch. Dr. Niki Deliman, MSD, developed the risk-based methodology and directed the project. Mr. Jeff Williamson, MSD, was principally responsible for software design and development and creation of the facility location methodologies used in the software. This report was prepared by Mr. Williamson and Dr. Deliman.

The developers of this document gratefully acknowledge the assistance of Ms. Susan Griffin Sippel, Mevatec Corporation, Vicksburg, MS, in production of this document.

At the time of publication of this report, Director of WES was Dr. Robert W. Whalin. Commander was COL Bruce K. Howard, EN.

Summary

This document presents the risk-based mobility methodology, related applications, and methods for generating various products derived from this approach. Conventional mobility analysis is concerned with generating a speed prediction for one vehicle or a unit of vehicles operating in a specified terrain in order to identify areas of immobilization and derive other information such as time associated with traversing a given route. The risk-based approach moves beyond conventional mobility analysis by factoring in uncertainties concerning actual vehicle speed outcomes to present a range of speed outcomes associated with a specified terrain. This information can be used to derive useful and insightful decision aids and plan for best-case or worst-case scenarios.

The risk-based methodology was purposefully implemented within a known platform, the Comprehensive Army Mobility Model System - Developmental (CAMMS-D), to meet the Geographic Information System (GIS), user interface, and graphical display requirements for demonstration and for user feedback regarding risk-based capabilities. In this way, the project focus was on creating and determining ways to present applications and products. Consequently, a significant portion of this document is concerned with aspects of CAMMS-D that are not specific to risk-based applications but that are necessary for utilizing them.

Several risk-based applications have been developed to provide insight for ground mobility assessments. These include: identification of high probability NOGO areas, where "high" can be defined by the user; named areas of interest that depict areas favorable for travel; maximum and minimum arrival times associated with identified mobility corridors; and several others. By having the risk-based methodology available on a demonstrable system, it is the intention that this will encourage users to be creative in determining other decision aids or products that are useful for a variety of functions.

1 Introduction

General

The purpose of this document is to provide the user with the basis for generating insightful risk-based mobility products related to ground vehicle mobility, such as tactical decision aids (TDAs). The concept behind the software implementation of risk-based mobility modeling is to provide the commander with readily generated, geo-referenced mobility assessments that incorporate the effects of uncertainties in speed predictions by giving best-case to worst-case, or in-between case, scenarios. The software chosen to implement risk-based mobility capabilities is CAMMS-D, Comprehensive Army Mobility Model System - Developmental, which was produced and is in continuing development at the U. S. Army Engineer Waterways Experiment Station (WES).

Decision aids aimed at minimizing risk and exposing uncertainty in mobility measures can be readily created and displayed in the CAMMS-D environment. We do not assume that the user is familiar with this system and, as such, devote a considerable portion of this user's guide to explaining structure, functions, and capabilities particular to the software package. Moreover, it is necessary to create CAMMS-D base products, such as soil moisture and soil strength predictions, in order to build risk-based mobility products.

Risk-based applications in CAMMS-D were specifically designed to allow the user to construct complimentary or relational products that can be combined to provide insight above and beyond that of conventional ground vehicle mobility products. Risk-based predictions are created by the program at the same time that conventional speeds are produced and have a negligable associated computational time. It is our hope that this utility will serve as a valuable tool to mobility analysts and that this means of implementation will spur the user to create many types of mobility products that we have not yet envisioned.

About Risk-Based Mobility

Consider vehicles moving on-road or cross-country in a demanding and unfamiliar environment. Drivers are trying to maximize the performance of the vehicles. Where can friendly units travel without becoming immobilized? Where can the threat get through? What is the fastest route from one point to another? How long will it take to get there?

Conventional mobility analysis involves generating one mobility prediction for each homogenous area of terrain for one vehicle or a group of vehicles to identify severely restricted (NOGO), restricted (SLOGO), and unrestricted (GO) areas. These predictions can in turn be used to find the associated fastest route between two points or calculate the average speed along a specific route. These conventional mobility applications are available in what we term the CAMMS-D base package.

In reality, there is not one exact or deterministic answer for the actual resulting vehicle speed but rather a range of likely outcomes that result from the influence of various real world factors. Risk-based mobility analysis takes the conventional analysis one step further by determining best-case to worst-case limits on the mobility predictions and assessments made with these predictions. So, for example, instead of calculating one possible time estimate for a route, the minimum, maximum, and average expected traverse times are produced. Recall that model predictions are for achievable speed so risk-based predictions encompass best-case and worst-case for greatest achievable speed. All routes that require longer than some predetermined time to traverse might be eliminated from consideration. Similarly, areas with a high likelihood of NOGO can be separated from areas with marginal likelihood of immobilization. It might prove useful to reconnoiter marginal likelihood NOGO areas to determine if passage (threat or friendly) is possible. This type of added information allows risk, associated with mobility assessments, to be factored into courses of action.

The risk-based mobility modeling effort, including implementation into the CAMMS-D software, was supported by the Military Research Development Test and Evaluation Program and was developed under the stochastic mobility modeling program at WES. Motivation for this research in stochastic mobility modeling grew out of the realization that a one-to-one correspondence between speeds predicted by mobility models and actual speed measurements does not exist. That is, speed outcomes are variable (stochastic); for multiple trials with drivers trying to achieve maximum speeds on each trial, speed measurements will vary for tests conducted with the same vehicle over terrain of the same description. Note that this should not be surprising since there are many factors and processes at work that are not explicitly modeled. For instance, driver response and vehicle condition play an important role in speed outcome. In addition, many model relationships are treated deterministically although there are not exact (deterministic) responses. For more information on the stochastic mobility modeling efforts, the interested reader is referred to

Deliman and Lessem (1993 a and b) listed in the Bibliography. Specific work documenting the development of the risk-based mobility modeling methodology can be found in Deliman and Bunch (1995 working paper).

The two issues at the heart of the stochastic mobility modeling effort are: (a) how to relate actual values to predicted values and (b) how to use knowledge about uncertainty in speed outcomes to an advantage. Speed predictions in CAMMS-D and results derived for risk-based mobility are based on the NATO Reference Mobility Model (NRMM) which was developed jointly by WES and the US Tank-Automotive Command, primarily. For more information on NRMM, the interested reader is referred to Ahlvin and Haley (1992).

About CAMMS-D

Risk-based mobility procedures have been implemented in the CAMMS-D system. The system used is based on the Geographic Information System (GIS) used in Airland Battlefield Environment (ALBE), developed under the Airland Battlefield Environment Technology Demonstration Program, and runs in a user-friendly UNIX environment. The system is compatible with Army Battlefield Command System common hardware and software. There are a number of base modules in the CAMMS-D system. The base modules consist of components to read and manage terrain, vehicle, and scenario data; run and display soil moisture and soil strength predictions; incorporate weather conditions; and run and display the mobility speed predictions. Mobility predictions can be made for one vehicle or units of vehicles in tactical formations and can include both on- and off-road conditions as well as river and stream crossings. In this document CAMMS-D refers to the base modules and the risk-based utilities.

Vehicle, terrain, and scenario data are needed to run the system. The terrain products utilized are Interim Terrain Data (ITD), Digital Terrain Elevation Data (DTED), and Arc Digitized Raster Graphics (ADRG) which can be obtained from the Defense Mapping Agency. Formatted vehicle files describing many vehicle characteristics, such as inertia, weight, center of gravity, etc., are available from WES.

About this Document

As stated previously, prior knowledge of CAMMS-D is not required. A large segment of this user's guide presents pertinent information on the CAMMS-D base package (i.e., separate from risk-based utilities) and was taken from the ALBE Tactical Decision Aid User's Guide (1993) sections produced at WES. This user's guide contains the rationale behind the risk-based approach to ground vehicle mobility, the hardware and software requirements for the system, the information on loading and activating the system, the steps

needed to produce mobility speed predictions, and the steps needed to create various TDAs, or products.

There are various naming conventions used throughout this document. The terms mobility assessment, mobility evaluation, and mobility analysis are used interchangeably to indicate area speed predictions and derivatives of the predictions. Risk-based indicates that the uncertainty in mobility outcomes creates risks associated with decisions based on mobility analyses. Exploring the effects of uncertainty in outcomes by looking at best-case and worst-case scenarios allows risk to be factored into decisions. System menus refer to TDAs; however, there are applications outside the tactical arena that can utilize the same procedures. Therefore, product is used as a more generic term.

The document is organized logically into sections. First the connection between system applications is discussed in Chapter 2. Chapters 3 through 8 are concerned with CAMMS-D system installation requirements, the user interface, and system management. Processes involving examining terrain factors, creating soil strength predictions used in making speed predictions, and modifying weather data are discussed in Chapters 9 through 11. Risk-based utilities are presented in Chapters 12 through 18 along with example uses. Technical support is discussed in Chapter 19.

About this Product

This product, the CAMMS-D system with risk-based utilities, has not been officially validated or tested in actual performance. It is, however, believed to be a good product founded on sound research. Note that over 15,000 actual field test measurements were used to establish the relationships employed in the risk-based utilities.

This product is intended to demonstrate the advantage of realistic vehicle speed outcomes, as opposed to one typically biased value, on mobility perspectives and courses of action. It is assumed that terrain descriptions are reasonably accurate. Vehicles that perform substantially differently from the military vehicles used to develop the risk characteristics, e.g., in terms of vehicle-terrain interaction, will most likely not be modeled well by this product.

The products are meant to aid the decision maker by conveying the possible mobility related outcomes factoring in best-case/worst-case scenarios. However, the intent is to provide information to support the user's efforts and not to replace experience or intuition. Remember, the focus of this product is aimed at reinforcing the shortfalls associated with a "one possibility" or "the exact answer" approach. It is hoped that, as users become familiar with the system, they will move beyond the applications outlined in this user's guide and create various risk-based products from the available procedures that provide valuable insight and enhance the decision making process.

2 The Big Picture

General

The purpose of this chapter is to introduce the system applications, with particular emphasis on those that are risk-based, and discuss how they compliment or build upon each other. Applications are divided by function into three product groups: Terrain Factors, Weather Effects, and Ground Mobility. Within the Ground Mobility product group there are additional categories and subgroupings based on types of mobility functions. The risk-based utilities are found within the Ground Mobility product group. First, the relationship between product groups is discussed. Then, the types of products available in each product group are presented and the relationships between products are discussed.

Product Hierarchy

The products or applications in the Ground Mobility product group require results from the Soil Moisture Strength Prediction (SMSP) found in the Weather Effects product group. Furthermore, some products within Ground Mobility product group require that other products within the group be created first. On the other hand, the applications available in the Terrain Factors and Weather Effects product groups do not use products produced outside their group to generate results.

Weather and terrain factors impact ground mobility. The Terrain Factors product group contains utilities that allow the user to view overlays of various terrain features. The applications within this product group do not pass results to or require results from the applications within the other product groups. For example, the terrain factor overlays can be used to check or provide insight into mobility evaluations produced within the Ground Mobility product group but the Terrain Factors products are not needed by the Ground Mobility applications. The Terrain Factors product group is discussed in Chapter 9. In order to make ground mobility assessments in the CAMMS-D system, soil strength predictions from the Weather Effects product group must first be run. Note, however, that the Weather Effects applications can be run independently

of applications in the Terrain Factors and Ground Mobility product groups. The Weather Effects applications are discussed in Chapters 10 and 11.

There are 16 different terrain feature or factor overlays that can be created in the Terrain Factors product group. These factors deal with visibility; elevation; land classification; slope category; soil type; surface roughness; vegetation spacing; drainage, transportation, and railroad networks; and lock and dam locations. Selecting this product group and choosing a terrain factor menu item will generate the corresponding overlay. None of these products builds upon another. That is, none must be created prior to another. However, it may be useful to create combined overlays showing multiple features.

The Weather Effects product group contains five menu items: Soil Moisture Strength Prediction (SMSP), Update Weather Reports, Add Weather Gauge, Delete Weather Gauge, and Edit Weather Gauge. The SMSP is based on weather information that can be modified using the other four menu items dealing with weather reports and gauges. The SMSP application does not require that any of the four menu items be exercised prior its use. Note that the weather gauges measure precipitation. Adding, deleting, or editing weather gauges or updating weather reports provides the user with the capability to reflect the current weather situation and to presumably obtain a more accurate soil moisture, and then strength, estimate.

The Ground Mobility product group contains applications, including risk-based applications, that are further grouped into the following areas: Mobility Assessment, Route Planning Tools, Time Contour Analysis, and Facility Location. Mobility Assessment applications are concerned with producing overlays related to GO, SLOGO, and NOGO areas and to accompanying speed controlling factors. These applications are discussed in Chapter 12. These overlays incorporate risk by allowing the user to display best-case, worst-case, or in-between case outcomes. The Route Planning Tools use information from the Mobility Assessment and include applications for identifying the best (fastest) route and estimated travel time between user-defined points or for allowing the user to determine the time window associated with traversing a user-defined route. The Route Planning Tools are discussed in Chapters 14, 15, and 16. Time Contour Analysis and Facility Location are also derived from vehicle speed predictions. The Time Contour Analysis produces overlays that depict the area that can be covered by a vehicle, or group of vehicles, starting at a given point in specified time intervals such as hourly intervals. Time Contour Analysis is discussed in Chapter 13. The distance vehicles can travel is computed using the speeds produced by the Mobility Assessment and can be based on best-case, worst-case, or other speed estimates. Facility Location also uses speeds generated from the Mobility Assessment and determines where to locate sites so as to minimize the number of sites needed to satisfy coverage of an area from the sites within a specified time window. Facility Location is discussed in Chapter 17.

The Mobility Assessment applications include Speed Overlays, Uncertainty Overlays, and Reason Overlays as products. The Speed Overlays depict NOGO, SLOGO, and GO areas for given vehicles in a given region. There are conventional and several percentile overlays available to the user: Conventional, 1st, 5th, 10th, 25th, 50th, 75th, 90th, 95th, 99th, and Other percentile which is user defined. The Conventional Overlay shows the mobility assessment as given by the model without factoring in risk and variability. The 1st percentile indicates worst-case and the 99th percentile indicates best-case extremes. Uncertainty Overlays depict areas recommended for reconnaissance (Recon Recommendations) and highlight areas of concern (Risk Assessment) by using information from one or more of the Speed Overlays. The Uncertainty Overlays are discussed in Chapter 18. Reason Overlays show the speed controlling factors, as determined by the mobility model, associated with the areas of interest and, as such, provide insight into the mobility evaluation.

The Route Planning Tools include applications for identifying mobility corridors and computing associated travel times or time windows (i.e., maximum and minimum arrival times). As stated previously, these applications require speed predictions generated by the Mobility Assessment procedure. The user can identify speeds associated with any of the various speed overlays to use in deriving these route oriented products. Two types of mobility corridor products are available: Mobility Corridors (Automated) and Mobility Corridors (User Defined). The Mobility Corridors (Automated) procedure identifies the best (fastest) route between user specified points. Note that the user has the option of using best-case, worst-case, or in-between case speed estimates when identifying a route so as to reflect conservative or nonconservative estimates. Using the Mobility Corridors (Automated) sub-menu item, Estimated Time of Arrival (ETA) discussed in Chapter 15, an expected time interval for traversing the identified route will be computed. The other sub-menu option is Named Areas of Interest (NAI) and is discussed in Chapter 16. The NAI is used to identify areas used by several likely mobility corridors. The Mobility Corridors (User Defined) computes the travel time associated with a user delineated route.

There are several other products that the user can create by combining overlays from the various applications. For example, a best route produced using the 50th percentile speeds with the Mobility Corridors (Automated) option could be overlayed with areas that are highly likely to result in NOGO so as to see if the route contains potential areas of immobilization or comes close to them. It is the authors' intent that the user explore the potential uses for these products and create customized decision aids that fulfill specific needs.

3 Getting Started

Introduction

Information contained under the following heading, "CAMMS-D Hardware and Software Requirements", provides a description of the requirements for the two computer platforms supported by CAMMS-D. Steps necessary for loading the CAMMS-D software onto any one of these platforms need to be performed only once, as described under the second heading "Loading the CAMMS-D Software". Paragraphs following the third and last heading, "Activating the CAMMS-D Software", describe steps necessary to activate the CAMMS-D software each time the software is used, plus steps to access some of the features of the software.

CAMMS-D Hardware and Software Requirements

Information under the following two headings describes the minimum hardware and software required for the two computer platforms on which the CAMMS-D software operates. Both computer platforms are UNIX based. Hardware periphials (compact disk (CD) drive, tape drive, color printer, color plotter, etc.) and other hardware features (such as network capabilities) that are useful, but not a necessity, with the CAMMS-D software are not included in these platform descriptions.

Intel-based 386 and 486 machines

To run CAMMS-D on an Intel-based 386 or 486, the machine must be equipped with a mouse, a graphics card (supporting at least 256 colors), a relatively large hard disk drive (at least 100 MB space), 16 MB RAM, and SCO Open Desktop 2.0 (ODT 2.0). The notation "ODT 2.0" implies that X-Windows 11 Release 4 (X11R4) and Motif 1.1 are included.

SUN Sparc Workstation

To run CAMMS-D on a SUN Sparc Workstation, the machine must be equipped with an 8-bit graphics device, a mouse, and 100 MB free disk space to accommodate the operating system (Sun OS 4.1x with X11R4 and Motif 1.1) and the CAMMS-D software.

Note: Requirements described above for the two hardware platforms called for at least 100 MB free disk space to accommodate each computer's operating system and the CAMMS-D software. CAMMS-D developers recommend, however, that each CAMMS-D computer be equipped with 1 Gigabyte of disk space to accommodate the computer's operating system, the CAMMS-D software, and the relatively large amounts of terrain data typically required (usually far more than 100 MB).

Loading the CAMMS-D Software

Since no standard installation method has been developed at the time of this publication, installation instructions are provided with the media on which CAMMS-D software is distributed. These instructions will be tailored to the type of media and the specific hardware platform on which it will be installed.

Activating the CAMMS-D Software

The following paragraphs describe steps necessary for activating CAMMS-D software each time the CAMMS-D system is run and include a brief description of the CAMMS-D Manager (CM). A more detailed description of CAMMS-D X-Windows and CM capabilities is included in Chapters 4-8 of this user's guide.

The CAMMS-D system is designed to be used with X-Windows and Motif software. Motif operates with X-Windows and provides user interface and graphical capabilities. For purposes of this user's guide, Motif capabilities will not be described separately; the term X-Windows will signify combined capabilities of X-Windows and Motif.

Throughout this guide, the phrase "pressing the button" will appear. This refers to moving the arrow to a window button or position on the computer monitor screen (button), and then clicking the left mouse button--i.e., then depressing the left mouse button and releasing it immediately. This procedure instructs the CAMMS-D software to perform a particular task.

X-Windows must be activated before invoking the CAMMS-D software. Contact your system administrator if you need assistance activating X-Windows.

When X-Windows has been activated, enter the following command at the UNIX prompt in the active window (i.e., in the window on the monitor screen which is accepting input from the keyboard).

```
mngr -rf mngr
```

A CAMMS-D Manager (CM) window similar to the following will appear.

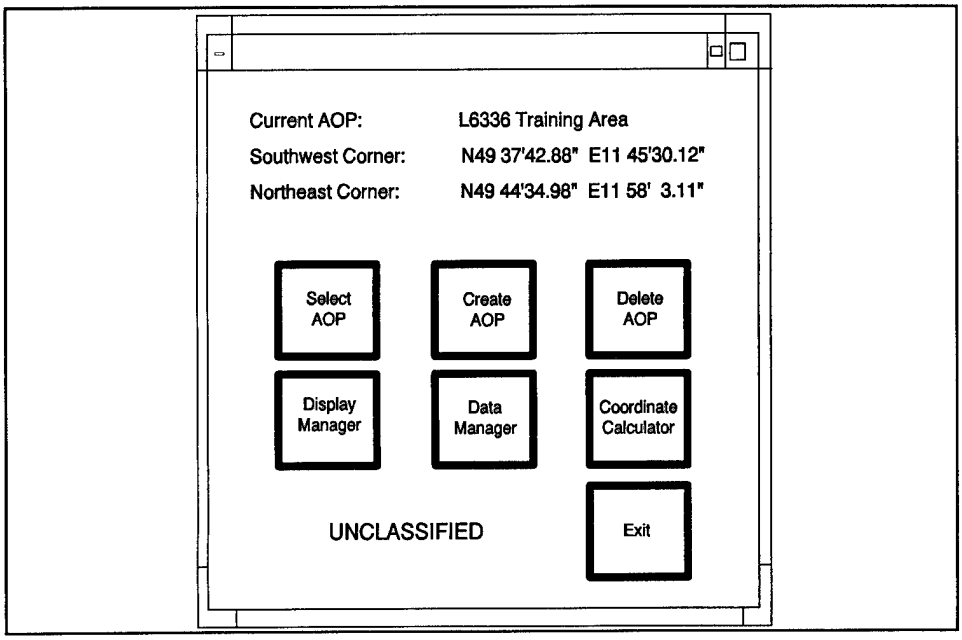

Figure 1. CAMMS-D Manager (CM) Window

The CM window contains a security classification indicator (UNCLASSIFIED, CONFIDENTIAL, SECRET, or TOP SECRET) in the lower left corner, plus seven buttons, the functions of which are described in Chapters 5 - 8 herein.

4 X-Windows and the CAMMS-D User Interface

X-Windows

The CAMMS-D system is designed to be used with X-Windows, which allows one or more "windows" to appear on a computer monitor. A "window" is a graphic user interface device. Each window allows a task to be performed and monitored. By having several windows, several tasks can be executed and monitored simultaneously. For example, Figure 2 shows a monitor screen with three windows.

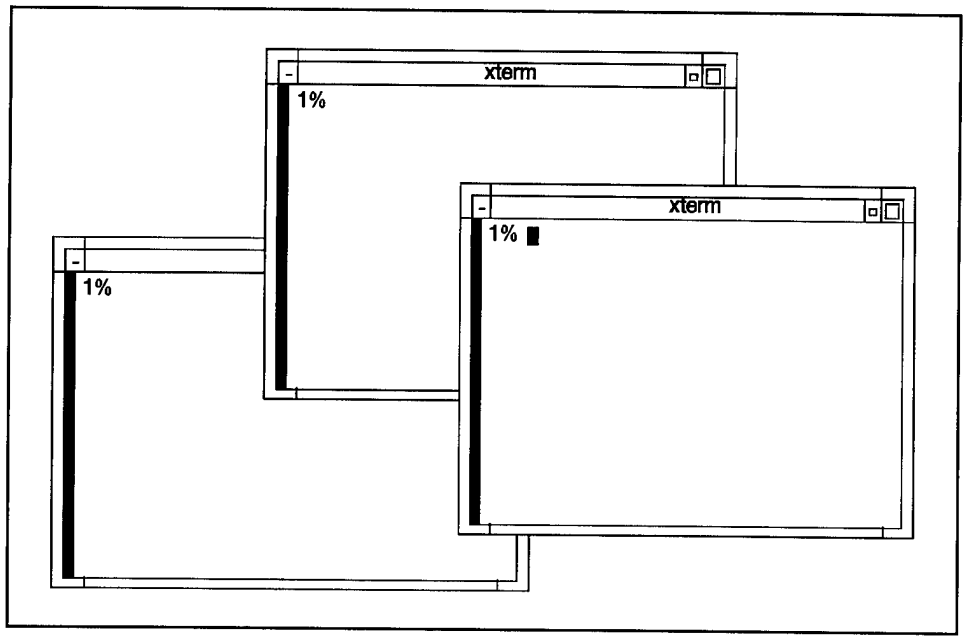

Figure 2. Monitor screen with three windows

In the previous illustration, each window performs similarly to a computer terminal or monitor. The fully outlined front window is the "active" window, meaning that any action from the keyboard will be reflected on this window. To activate an inactive window on most CAMMS-D systems, move the pointer with the mouse to any location within the window. If this action fails, move the pointer to the window activation bar and press the left mouse button to activate the window as illustrated below in Figure 3.

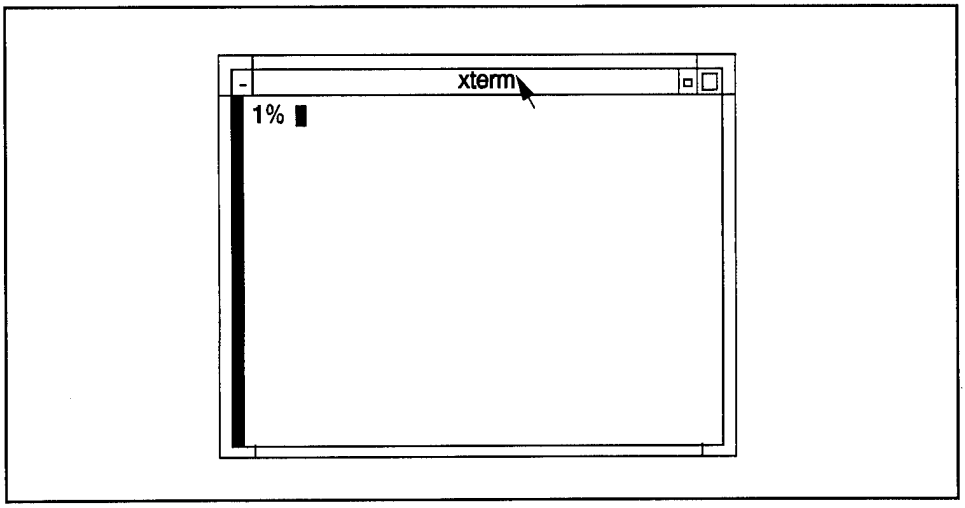

Figure 3. Activating a window

Figure 4 illustrates the various parts of an X-Window.

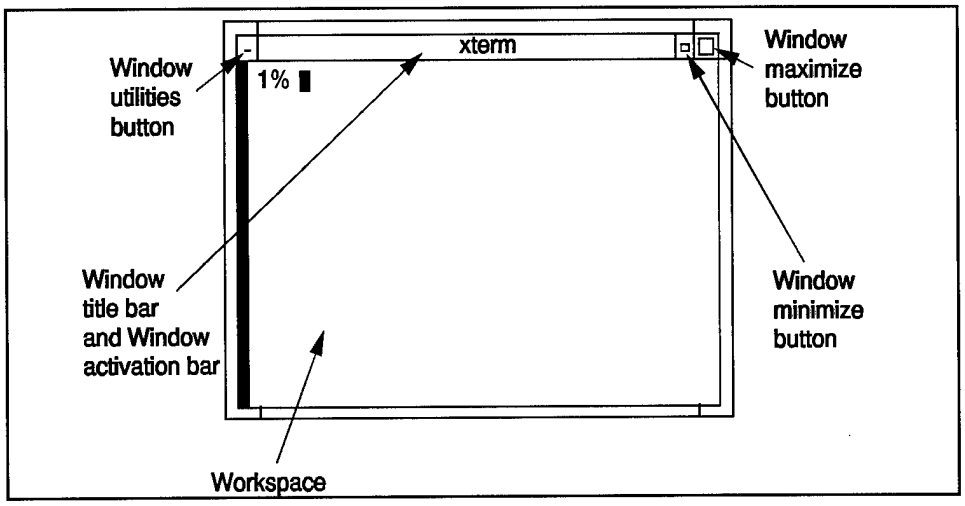

Figure 4. Parts of an X-Window

Figure 5 shows examples of X-Window buttons.

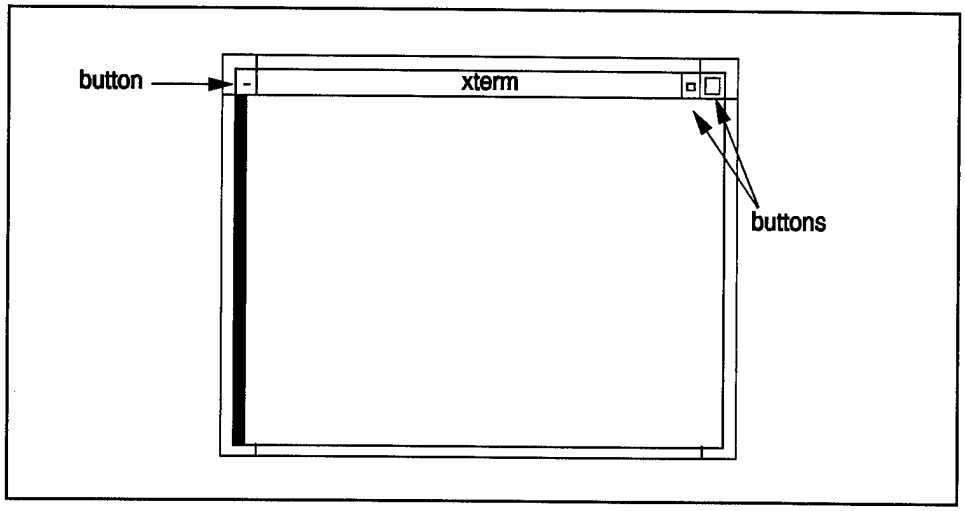

Figure 5. X-Window buttons

X-Window buttons will hereafter be referred to as "buttons"; buttons on the mouse will be referred to as "mouse buttons".

Windows can be moved from one location on the monitor screen to another. This is accomplished by placing the graphics arrow on the window activation bar of the active window and depressing the left mouse button. As long as the mouse button is depressed, the window can be moved by moving the mouse. An outline of the window will appear to assist the user in relocating the window. When the outline of the window is in the desired location, the user should release the left mouse button to complete the move process.

Sizes of windows can be altered to any dimensions. One method of altering a window's size is to place the pointer on the border of the window and then depress the left mouse button. While the left mouse button is depressed, the sides of the window can be moved. When the window is of the desired size, the user should release the left mouse button.

Pressing the button in the upper left corner of a window causes the following window utility menu to be displayed (Figure 6).

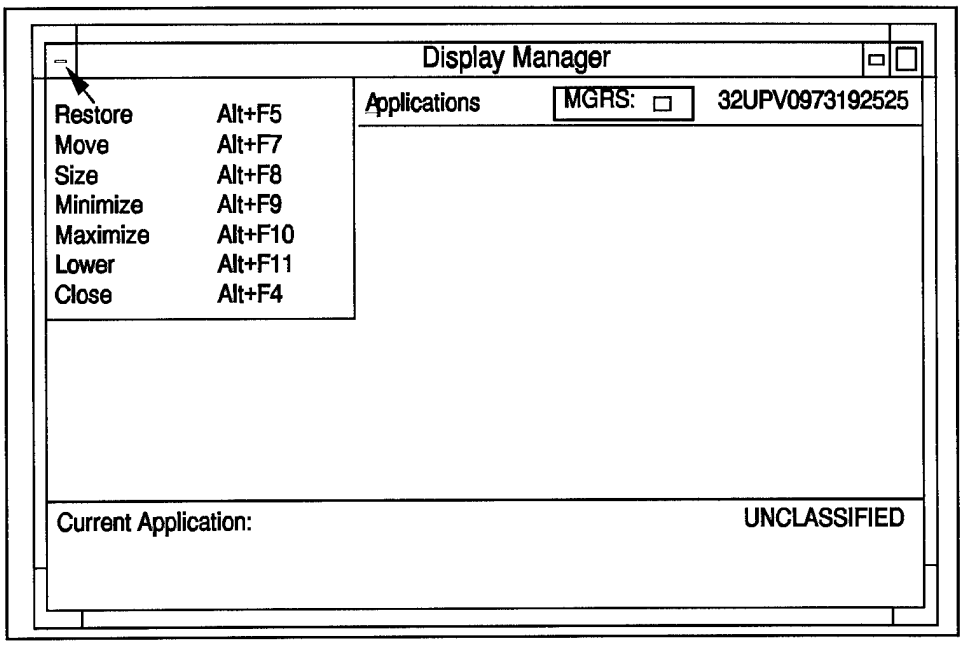

Figure 6. Utility window

Selection of a given entry in the above window utilities menu causes the following actions.

a. Restore - Restores to its previous size a window whose size had been altered.

b. Move - Allows the user to move a window to a new location. (This menu item performs the same task as pressing the active window activation bar.)

c. Size - Allows the user to resize the window.

d. Minimize - Shrinks the window to button size (i.e., to an icon).

e. Maximize - Enlarges the window to full-screen size.

f. Lower - Moves the window behind all other windows; if the window is the active window, it may remain the active window, however.

g. Close - Eliminates the window.

Each of the above menu items can be accessed by moving the arrow to the item and clicking (pressing and releasing) the left mouse button. In the above illustration, notations to the right of the menu items ("Alt+F5", "Alt+F7", etc.) mean to press the "Alt" key and the specified function key ("F5", "F7", etc.) simultaneously. These notations represent alternate methods of utilizing each of the menu items.

CAMMS-D User Interface (UI)

The CAMMS-D UI includes on-screen cursors, buttons, switches, menus, lists, input fields, and forms. The CAMMS-D UI employs the use of the mouse and keyboard for retrieving input from the user. Each element of the CAMMS-D UI is described in the following paragraphs.

Mouse

A mouse is a graphics pointing device which may have two or three buttons (referred to as "mouse buttons") that are used to perform graphics tasks. The mouse is used to move a cursor (pointer) to various locations on the computer monitor screen. When the cursor is placed in the desired location, the user can execute an operation (initiate a process, provide input, etc.) by pressing the mouse button(s).

Cursors

In CAMMS-D, users may encounter five different cursors, or pointing devices, described and illustrated as follows (Figures 7 - 11).

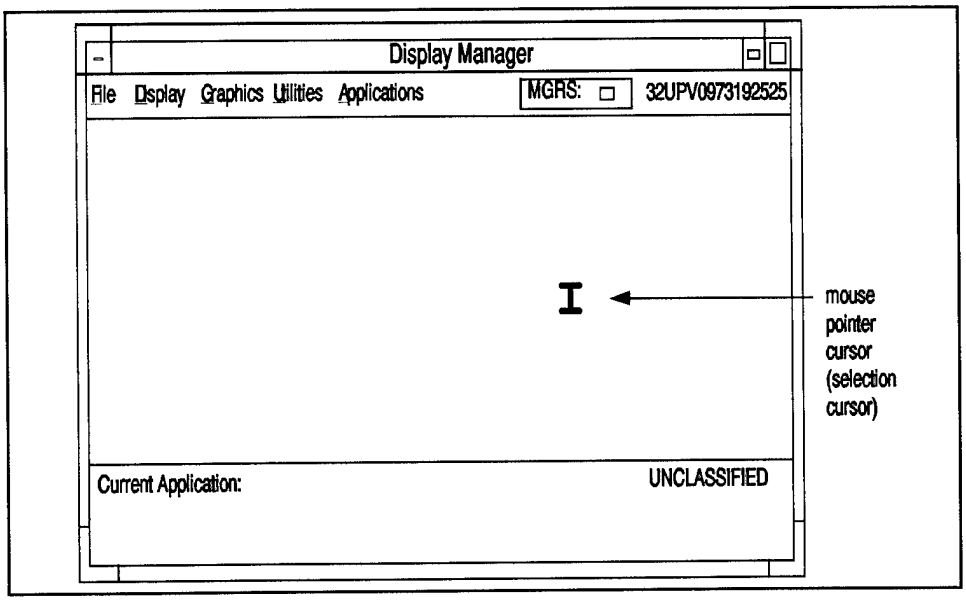

Figure 7. Mouse pointer cursor (selection cursor)

The selection cursor shown in Figure 7 appears any time input from the keyboard is expected by the CAMMS-D software. This input may include UNIX commands to be entered at the UNIX system prompts or character string or number values to be entered at CAMMS-D system prompts.

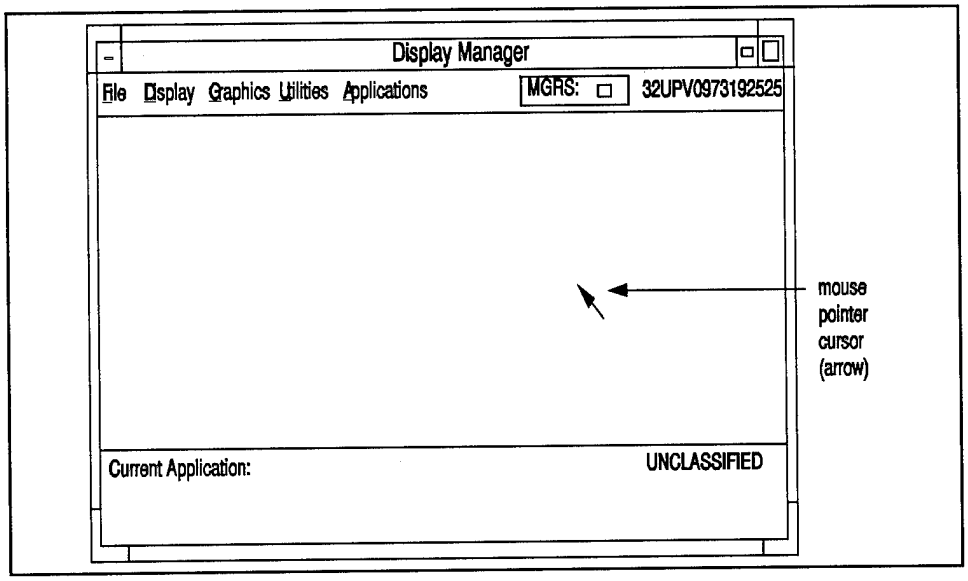

Figure 8. Mouse pointer cursor (arrow)

The arrow cursor above in Figure 8 (referred to as the "arrow" in this guide) appears when input from the mouse is allowed or expected. This input can be accomplished by highlighting and selecting a list or menu item, by pressing a button on a form, by toggling a switch, by pressing the window activation bar, by moving a window, etc.

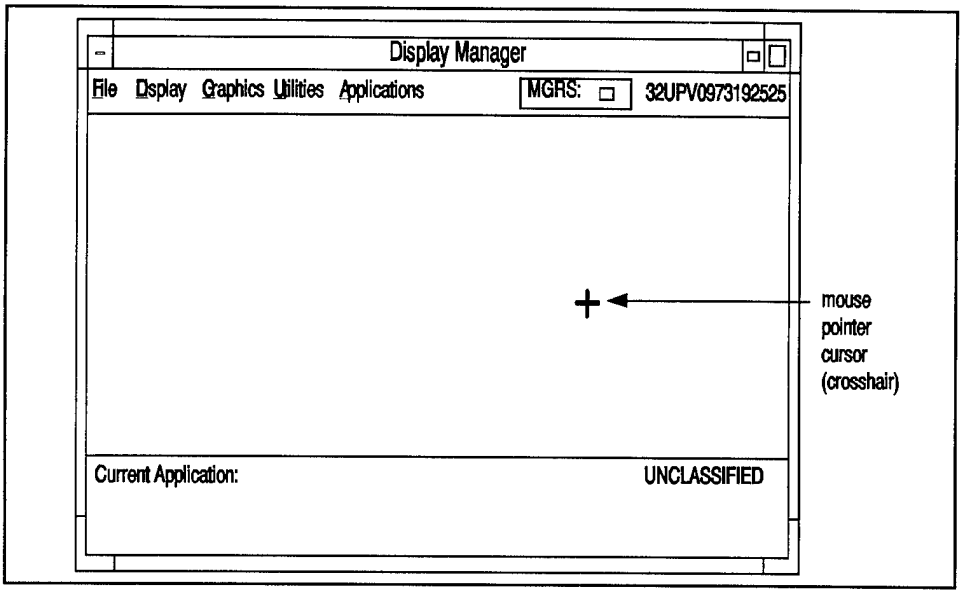

Figure 9. Mouse pointer cursor (crosshair)

A third cursor which appears in some CAMMS-D TDAs is the crosshair, as illustrated above in Figure 9. The crosshair is used to pinpoint a particular location on the computer screen; then, the user should press the left mouse button to finalize the selection of a location. Uses of the crosshair will be discussed subsequently within descriptions of particular TDAs.

A fourth cursor, the "hour glass" cursor appears within a particular form window when a selection has been made and a process has been initiated as a result of the selection; no other selections can be made until after the selected process has terminated. When a selection is allowed within the form in which the cursor is located, a cursor other than the "hour glass" cursor will appear. The "hour glass" cursor is illustrated below in Figure 10.

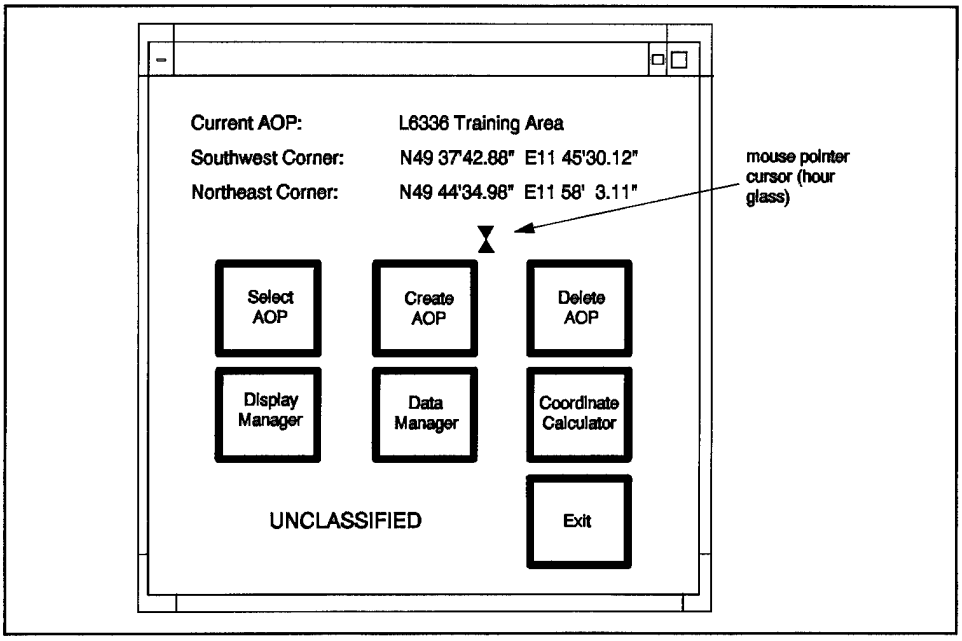

Figure 10. Mouse pointer cursor (hour glass)

A fifth cursor, the "hand" cursor, appears within the CAMMS-D Coordinate Calculator form. The "hand" cursor is illustrated in Figure 11.

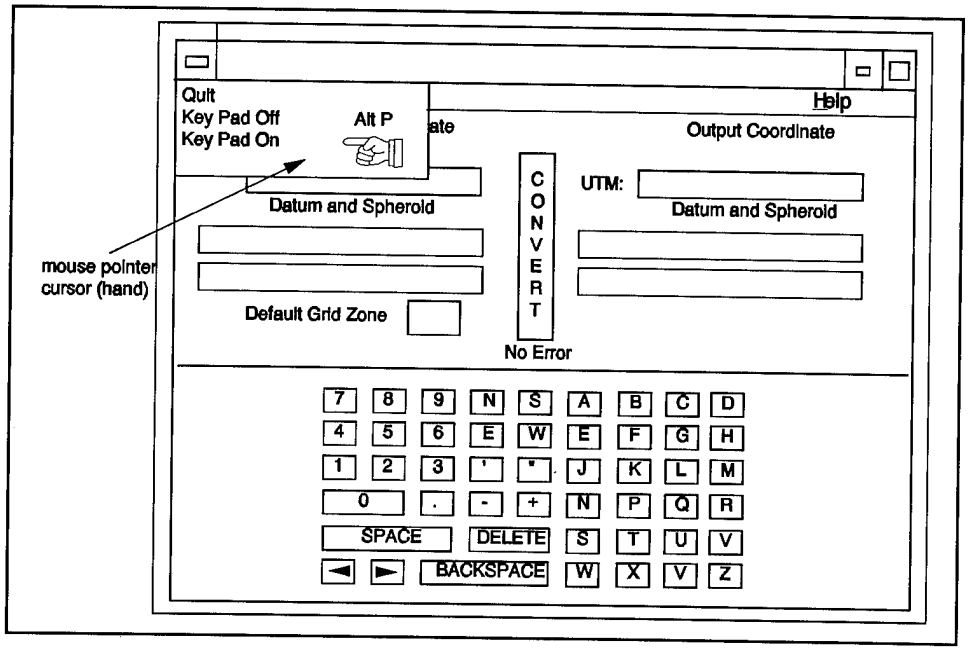

Figure 11. Mouse pointer cursor (hand)

Buttons

CAMMS-D uses two types of buttons, buttons on the mouse referred to herein as "mouse buttons", and X-Window and UI buttons referred to herein as "buttons".

Several aspects of mouse button operation have been described under the two preceding headings, Mouse and Cursors.

Buttons are represented on a form or window by small rectangles as shown in Figures 5 and 12.

This user's guide instructs the user to "press" a button on the form; this task involves moving the arrow to the button and clicking the left mouse button.

Two buttons which appear on most displays are "OK" and "Cancel". If the "OK" button is pressed, input entered at the prompt is accepted. Pressing this button may also instruct the system to continue a specified operation. The "Cancel" button usually is used to disregard any input provided on a given display or to end execution of an operation.

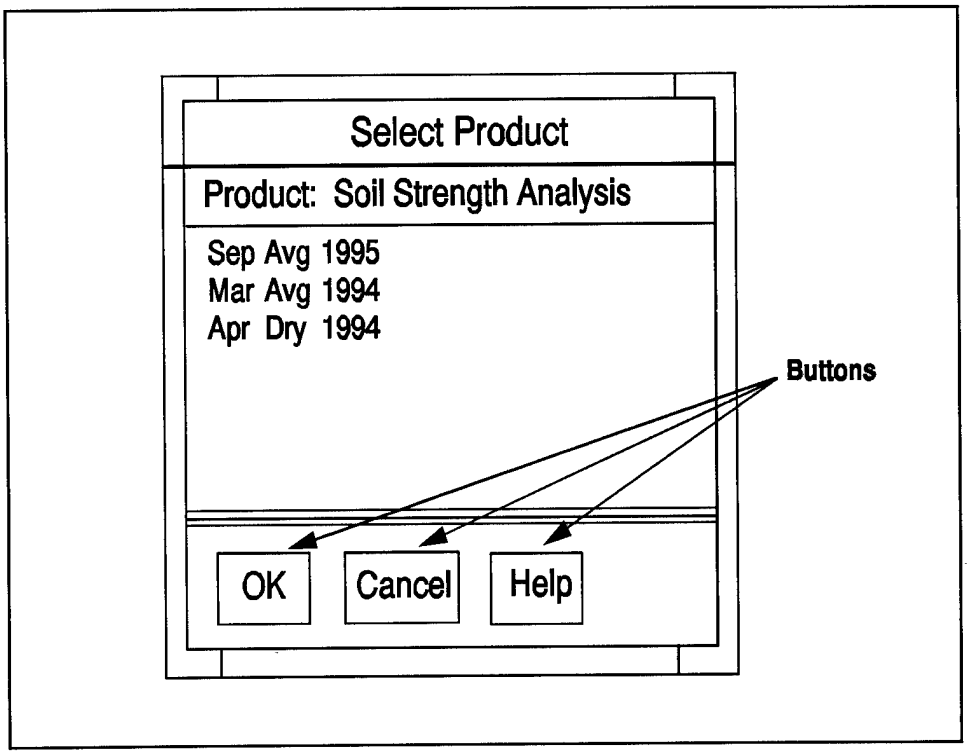

Figure 12. Example CAMMS-D buttons

Most windows include buttons in the upper left and upper right corners. The functions of these buttons were previously discussed in Chapter 4 under heading X-Windows.

Switches

Switches are buttons (represented by small squares on the computer screen) which can be used to turn an option or a condition "on" or "off" (toggle). For example, the following form (Figure 13) contains in the first column switches which indicate whether the weather gauge is active or inactive ("on" indicates that the gauge is active; "off" indicates that the gauge is inactive).

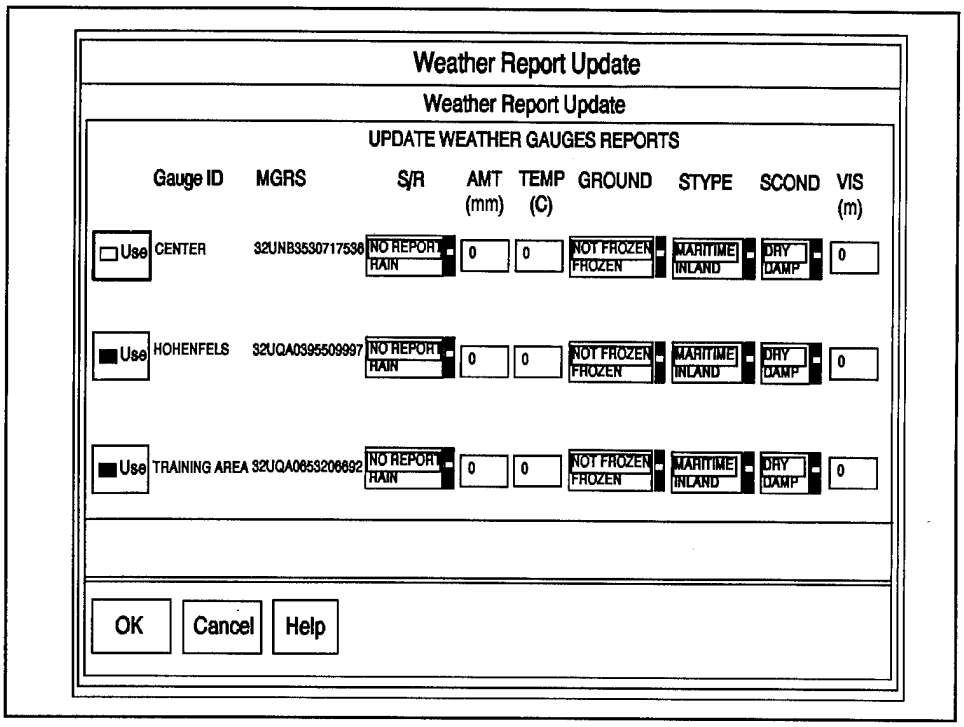

Figure 13. Switches

When the switch symbol is filled, the switch is "on"; when unfilled, "off". The status of these switches can be toggled by pressing the switch (in the same manner as pressing a button).

Menu

A menu is a list of items from which only one item can be selected at a time. The following (Figure 14) is an example menu.

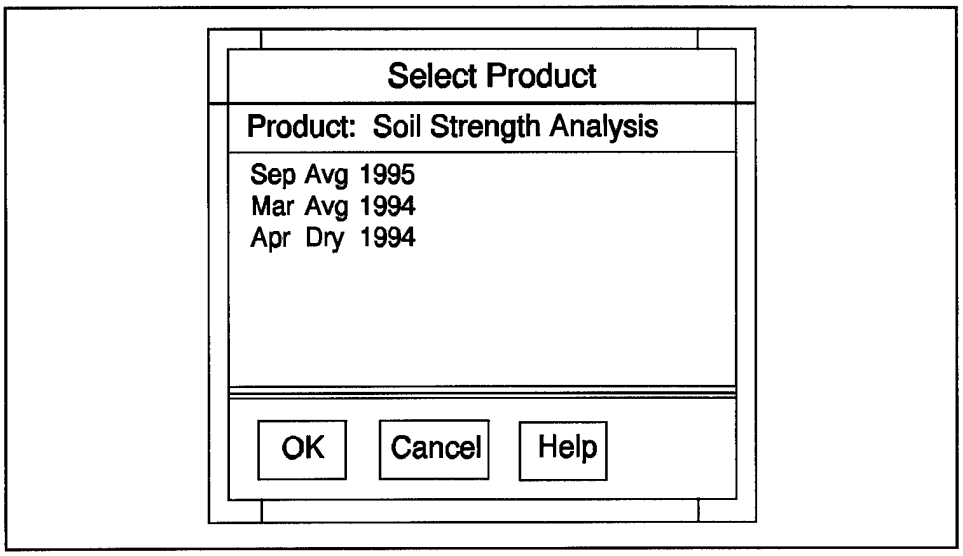

Figure 14. Example of menu

To select an item on a menu, the user moves the arrow to the item and clicks the left mouse button which is illustrated in Figure 15.

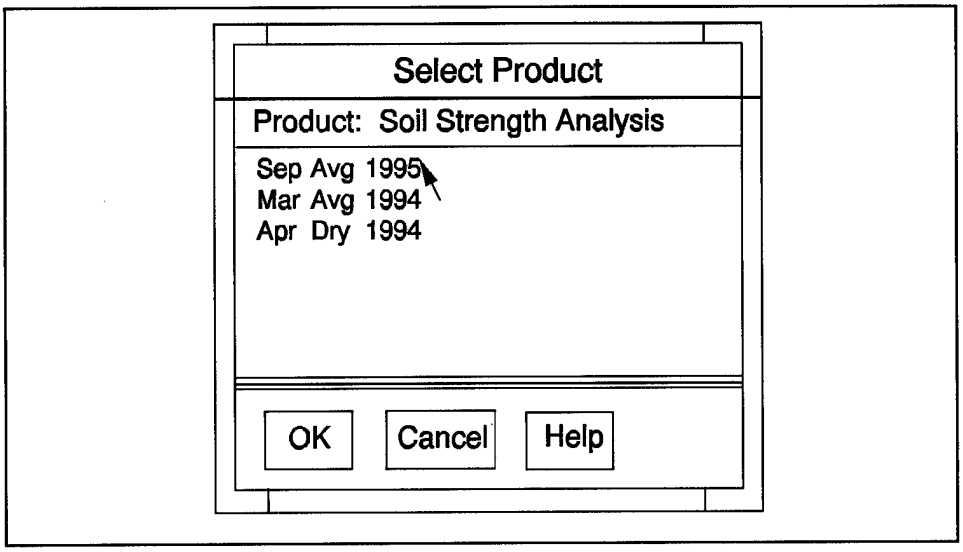

Figure 15. Example menu with cursor

The selected item will be highlighted on the menu which is illustrated in Figure 16.

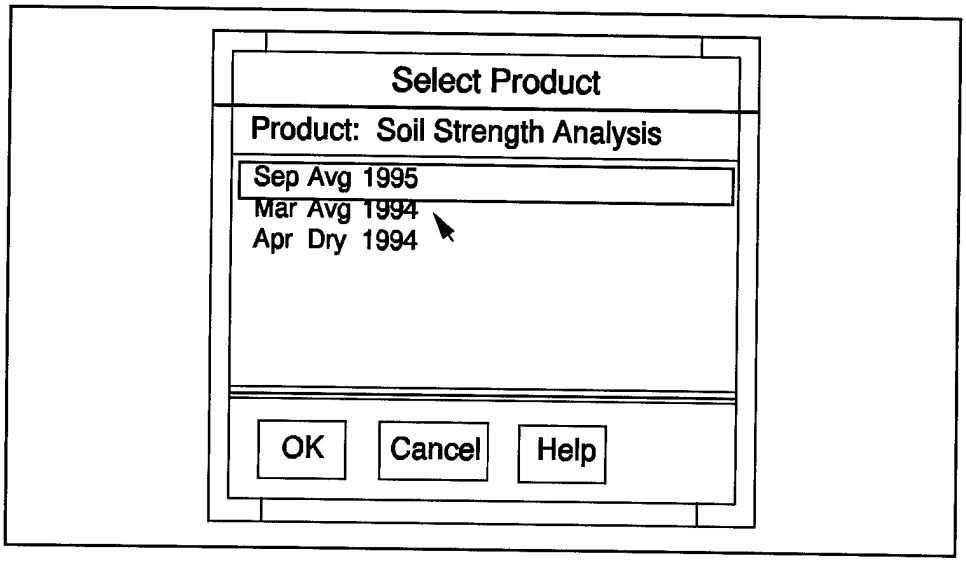

Figure 16. Example menu with selection

To finalize the selection, the user should press "OK"; to not accept the selection, press "Cancel" instead.

If a menu is longer than the space allowed for the menu to be displayed, "scroll buttons" and a "slide bar" will be displayed beside the menu. For example, a menu of 20 items can be displayed by scrolling within a space which allows only 10 items to be displayed at a time. This situation is illustrated in Figure 17.

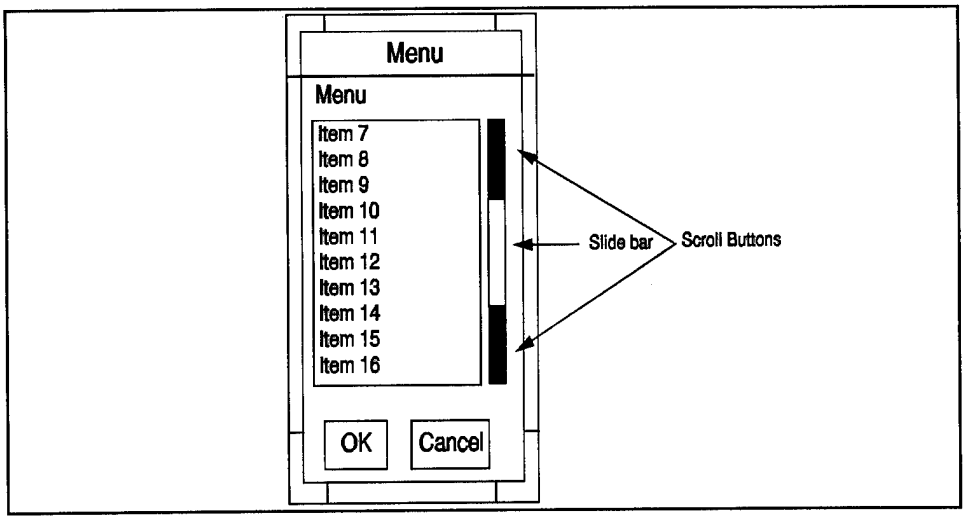

Figure 17. Slide bar and scroll buttons

To scroll through the menu using the scroll buttons, the user must place the mouse pointer on the scroll button which points in the desired direction of the scroll (up or down) and click the left mouse button. The user continues this action until the desired menu option is visible on the menu. To scroll through the menu using the slide bar requires the user to place the mouse pointer on the slide bar and then depress the left mouse button. As long as the left mouse button is depressed, the user can scroll through the menu by moving the mouse in the desired direction of the scroll. The user must release the left mouse button when the desired menu item is visible.

In some cases, "second-level" menus are associated with items on "first-level" menus like those described thus far. These second-level menus are called pull-down menus. Pull-down menus are "pulled-down" as a result of pressing certain buttons. For example, on the Display Manager main menu, if the user places the pointer on the "File" option and depresses the left mouse button, a pull-down menu will appear. This menu will remain visible as long as the user continues to depress the left mouse button. To finalize a selection from a pull-down menu, the user must move the pointer until the desired option is highlighted, and then release the left mouse button.

Lists

A list is similar to a menu; it differs in that some lists allow multiple selections to be made at the same time. Figure 18 is an example list.

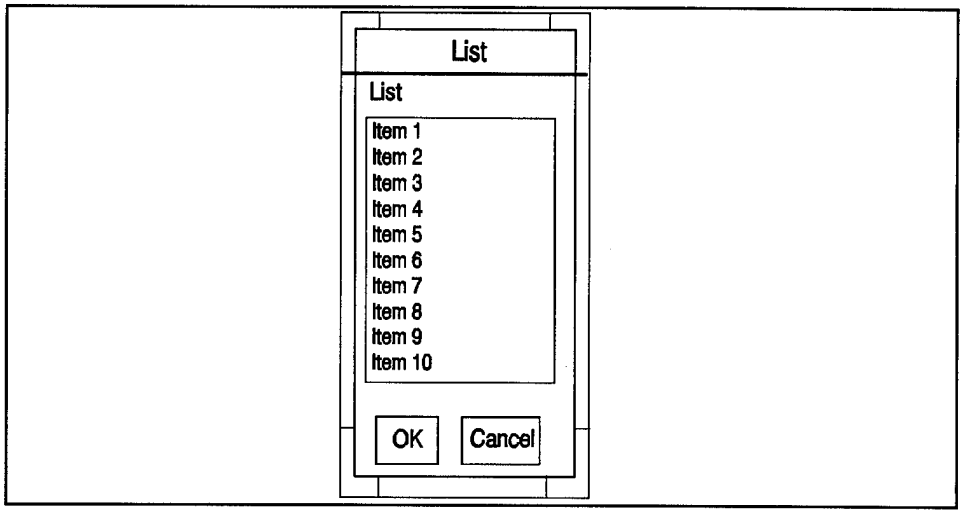

Figure 18. Example list

To select item(s) from a list, each desired item must be highlighted by moving the arrow to the item and then clicking the left mouse button. The following, Figure 19, illustrates a list with two items selected.

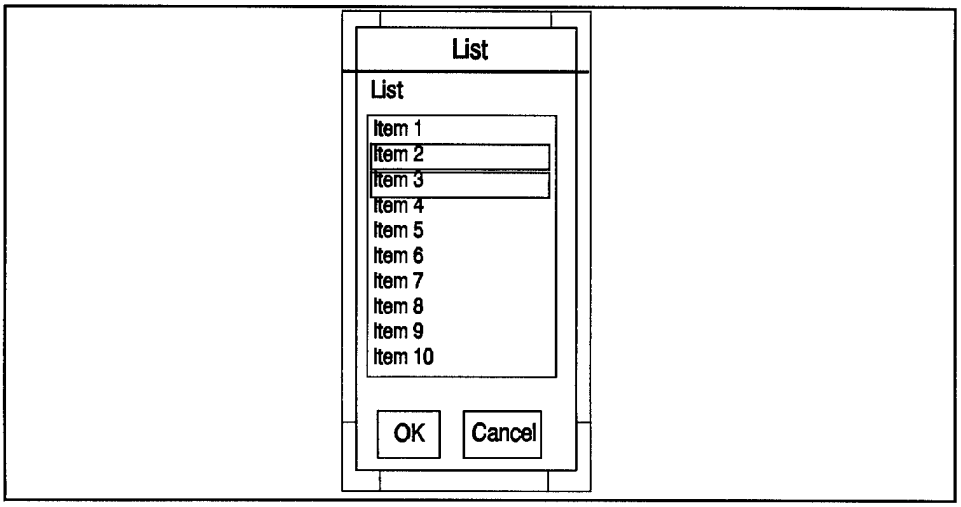

Figure 19. Example list with two selections

To finalize the selection(s), the user must press "OK"; to disregard the selection(s), the user must press "Cancel".

It is possible for some items in a list to be "preselected"--i.e., to be selected as default items by the CAMMS-D system developers. If this has been done, when the list first appears some of the items on the list will be highlighted. Any preselected items which the user does not wish to select must be deselected before "OK" is pressed. To deselect a preselected item, the user must move the arrow to the item and then click the left mouse button.

If a list is longer than the space allowed for the list to be displayed, a slide bar and scroll buttons will be displayed beside the list. For example, a list of 20 items can be displayed by scrolling within a space which allows only 10 items to be displayed at a time. This situation is illustrated in Figure 20.

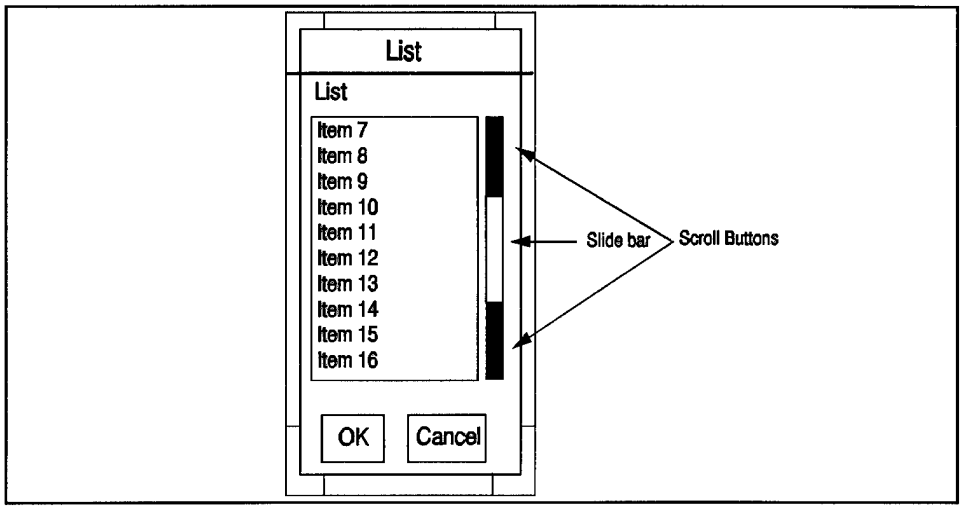

Figure 20. Slide bar and scroll buttons

The mechanics of using the scroll buttons and slide bar to display a list of more items than can be displayed at one time, within the display space, is the same as described in the last paragraph under heading "Menus" (for the corresponding situation involving menus instead of lists).

Input Fields

Input fields allow character strings or discrete numbers to be entered through a form, as illustrated in Figure 21.

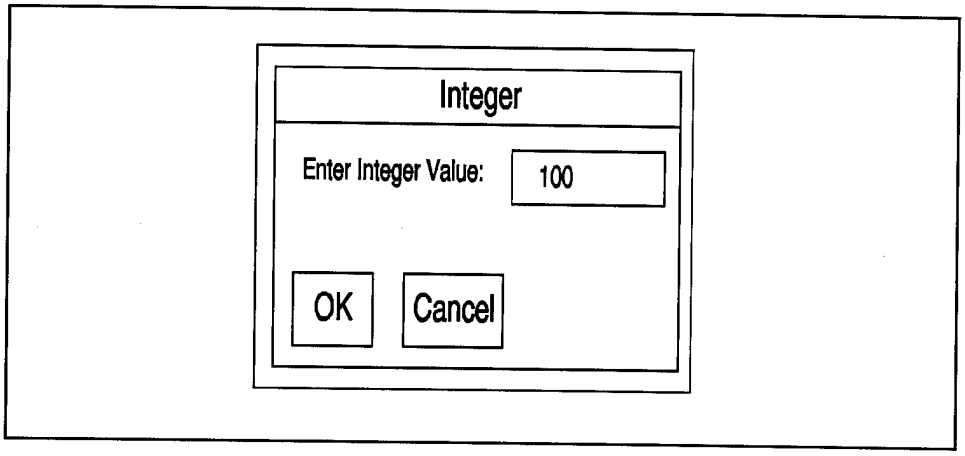

Figure 21. Sample discrete number input field

When the prompt appears, the user must place the cursor in the field which is to receive input from the keyboard. In this situation, the insert mode is active--i.e., any input will be inserted into the character string or discrete number at the position of the cursor.

Two quick clicks of the left mouse button will delete the current entry in the field and allow the user to begin making a new entry.

Forms

A given CAMMS-D UI form includes one or more of the following: buttons, switches, lists, and input fields. The following example form (Figure 22) contains each of these.

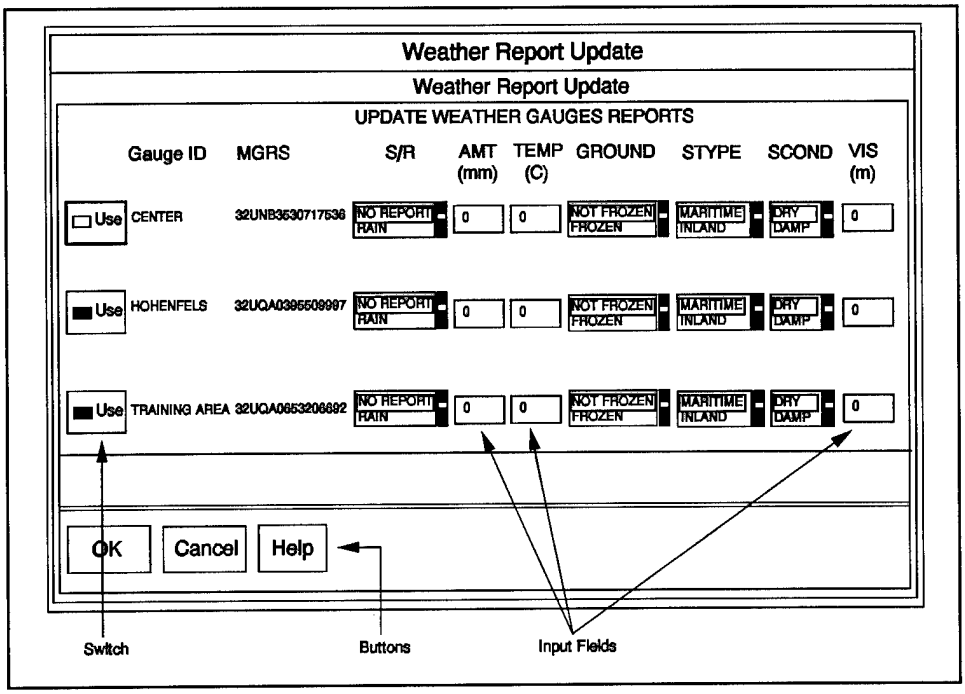

Figure 22. Example form

Buttons, switches, lists, and input fields operate within a form in the same way that they operate in other appearances on the CAMMS-D computer screen. Their operations have been described earlier in Chapter 3 under headings "Buttons", "Switches", "Lists", and "Input Fields", respectively.

On some forms, if the form values are improperly filled or selected, an error will be displayed. The following diagram in Figure 23 illustrates a form with an error.

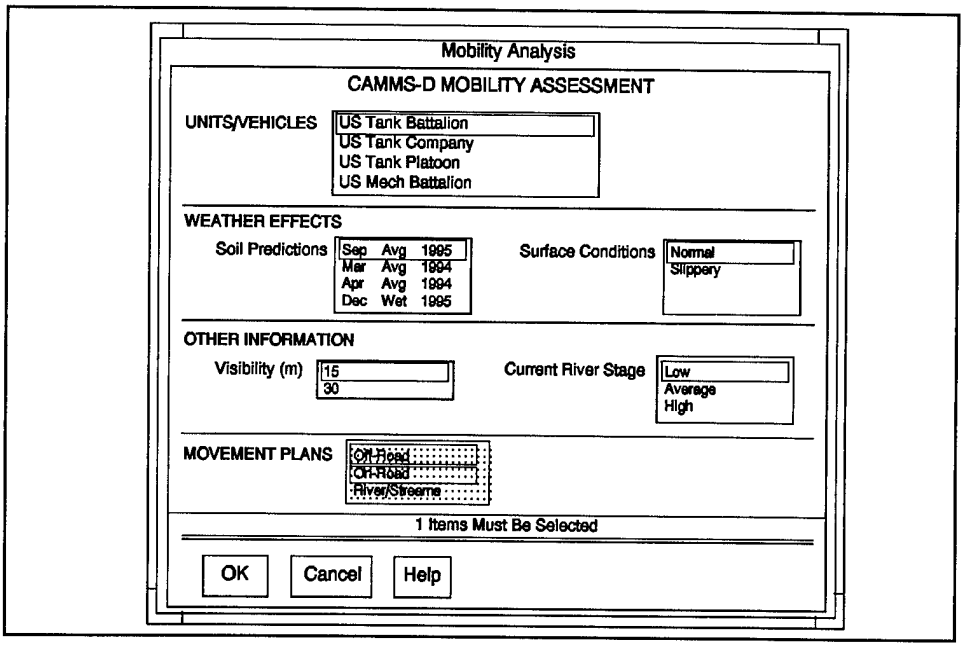

Figure 23. Example form with errors

In addition to an error message, an improperly completed entry will be highlighted in red. (In the above form, hash marks represent red.)

5 CAMMS-D Manager (CM)

Overview

When the CM is invoked, a window with several buttons appears. Figure 10 in Chapter 3 is an example of a CM window. The following paragraphs describe the CM and capabilities provided by the CM under the subheadings "Selecting, Creating, and Deleting AOPs", "CAMMS-D Display Manager (DM)", "CAMMS-D Data Manager (DatM)", "CAMMS-D Coordinate Calculator (CCC)", and "Exiting the CAMMS-D Manager".

Selecting, Creating, and Deleting AOPs

CAMMS-D applications perform their functions on a user-specified portion of terrain called an area of operation (AOP). The AOP is specified by a set of coordinates and a title. Capabilities of selecting, creating, and deleting AOPs are provided to the user by the CM buttons "Select AOP", "Create AOP", and "Delete AOP", respectively. The following paragraphs provide information needed by the user to utilize these capabilities.

Select AOP

Pressing this CM window button allows the user to select an AOP as the current (active) AOP. When this button is pressed, a list of AOPs created earlier by the "Create AOP" option will appear. An example is given in Figure 24.

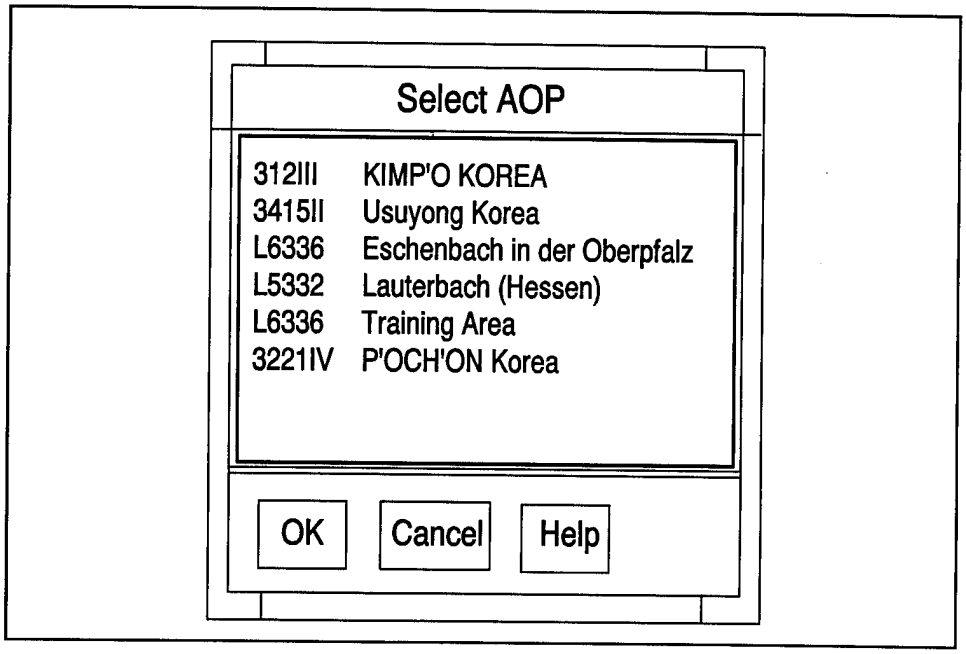

Figure 24. "Select AOP" List

The selected AOP becomes the current (active) AOP.

Create AOP

Pressing this CM button allows the user to create an AOP by supplying requested information, illustrated in Figure 25.

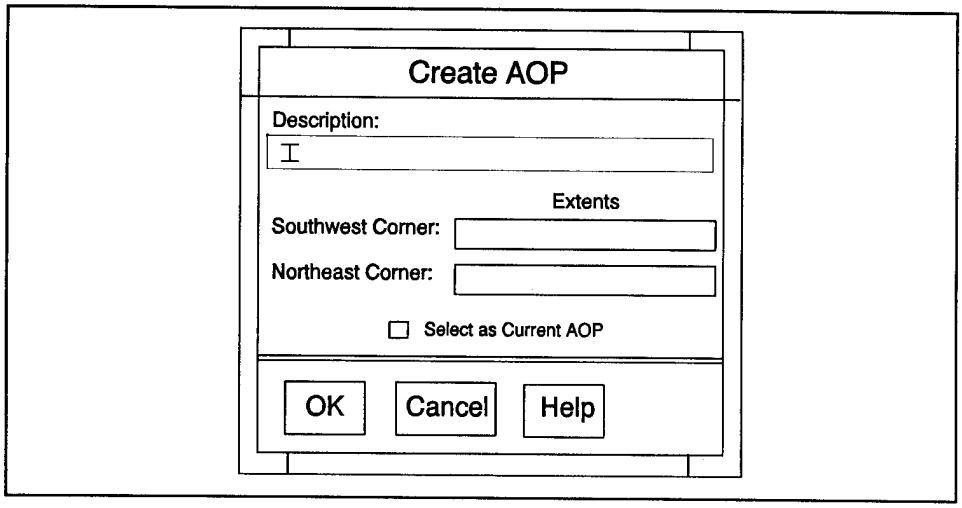

Figure 25. "Create AOP" form

When this form is completed and "OK" is pressed, the specified AOP will be created. This newly created AOP may be selected as the current area; otherwise, this new AOP will be available for selection later.

Delete AOP

Pressing this CM button allows the user to delete a previously created AOP. When this button is pressed, a list similar to the following in Figure 26 will appear.

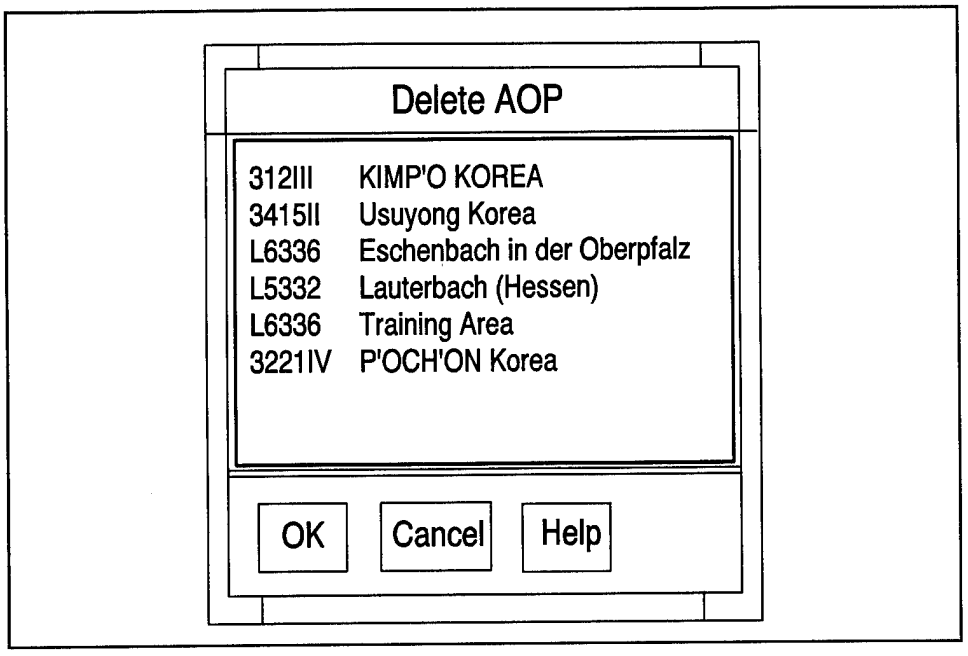

Figure 26. "Delete AOP" list

The user would then select an AOP in this list for deletion.

CAMMS-D Display Manager (DM)

The DM provides the user capabilities necessary to produce, display, manage, and analyze CAMMS-D TDAs, including capabilities to access and display digital terrain data. Details on the DM are provided in Chapter 6.

CAMMS-D Data Manager (DatM)

Pressing the DatM button of the CM provides the user the capabilities of importing Interim Terrain Data (ITD), ARC Digitized Raster Graphics (ADRG), and Digital Topographic Elevation Data (DTED) for use by CAMMS-D. The DatM also allows the user to remove unneeded data from the CAMMS-D system, to copy data to a tape, to copy data from a tape, and to view data available on the CAMMS-D system. Details on the DatM are provided in Chapter 8.

CAMMS-D Coordinate Calculator (CCC)

Pressing the CCC button allows the user to convert a coordinate from one system to another. The CCC supports the following coordinate systems: Universal Transverse Mercator (UTM), Military Grid Reference System (MGRS), and Geodetic (Latitude-Longitude). (Users should refer to "Datums, Projections, Grids and Common Coordinate Systems, Transformation of MIL-HDBK-600008 (draft, 1991)" for details on coordinate systems used by US military organizations.) When the user presses the CCC button, the following window in Figure 27 will appear.

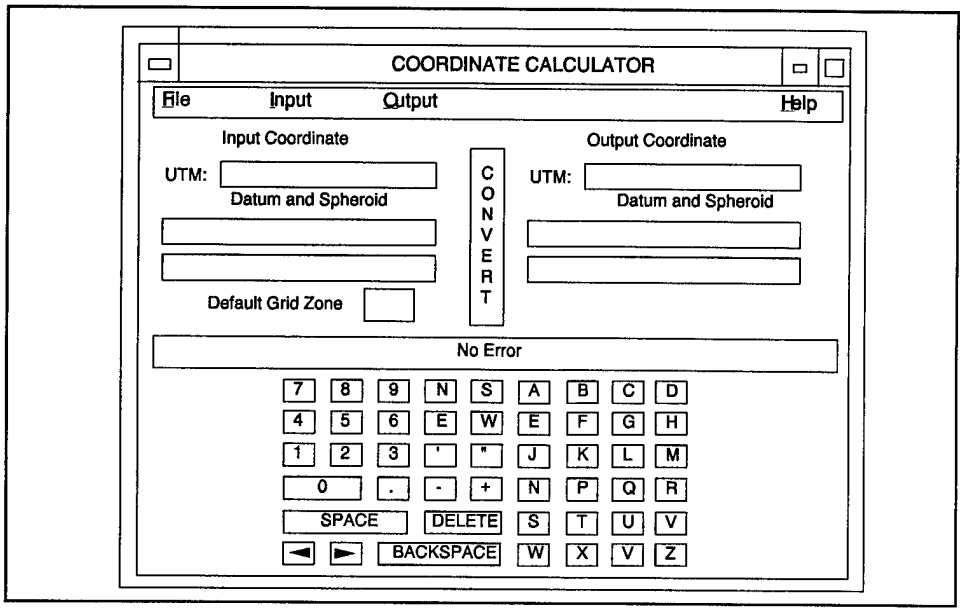

Figure 27. CCC Window

The items across the top of the window (File, Input, and Output) compose the CCC main menu. Selection of a given item in the above window causes the following actions.

a. *File.* Allows the user to leave (quit) the CCC or to toggle (turn on or off) the keypad located in the lower half of the CCC form.

b. *Input.* Allows the user to view the current settings of the input parameters for the coordinate conversion process, to select the coordinate type of the input coordinate, and to select the desired datum.

c. *Output.* Allows the user to view the current settings of the output parameters for the conversion process, to select the coordinate type of the output coordinate, to select the format of the output coordinate (UTM, MGRS, or Geodetic), and to select the desired datum and grid zone.

Also included on the same line as the CCC main menu is the option "Help". Selection of this option will provide useful information on using the CCC.

To utilize the CCC, the user should complete all input fields in the form (input coordinate and the datum of the input coordinate) by using the keyboard or the keypad located in the lower half of the CCC window. The remaining fields should be altered by using the "Input" menu option located in the CCC main menu; then, the user should press "CONVERT" located in the center of the screen. If any errors are incurred by the user's input, an error message will be displayed in the location where "No Error" currently exists.

The following is a list of instructions which could be used to convert the MGRS coordinate "32UNC3530028595", WGS '84 datum to a UTM coordinate.

a. Select "Input" on the CCC main menu.

b. Select "Coordinate Type" followed by "Military Grid Reference System (MGRS)".

c. Again, select "Input" on the CCC main menu.

d. Select "Datum".

e. Highlight "WGS 1984" and press "OK".

f. Select "Output" on the CCC main menu followed by "Coordinate Type".

g. Select "Military Grid Reference System (MGRS).

h. Select "Output" on the CCC main menu followed by "Coordinate Format".

i. Select "Military Grid Reference System (MGRS)".

j. From the resulting form, select the desired output format and accuracy of the output; press "OK".

k. Select "Output" from the CCC main menu followed by "Datum".

l. Highlight the desired datum of the output and press "OK".

m. Select "Output" from the CCC main menu followed by "Grid Zone". The following form (Figure 28) will appear.

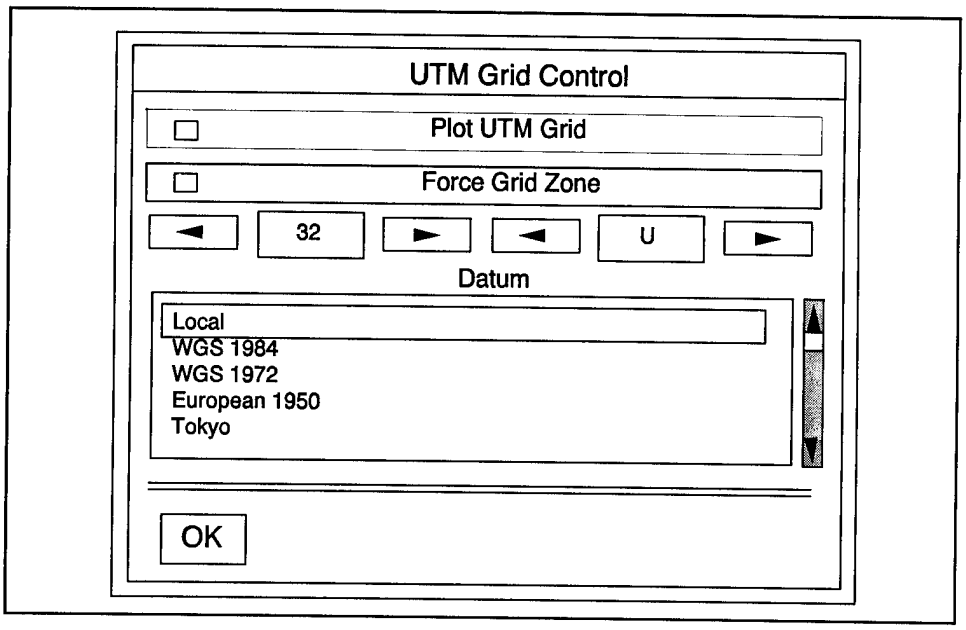

Figure 28. "Output UTM Grid Zone" form

The form illustrated above allows the user to "force" the input coordinate to be converted relative to a particular grid zone. This is accomplished by entering the desired grid zone and by "turning on" the "Force Grid Zone" switch. The grid zone on the form may be altered via the keyboard, or by pressing the "arrow" buttons to increment (right button) or to decrement (left button) the value within a particular field.

Exiting the CAMMS-D Manager (CM)

Pressing the CM button "Exit" causes the CM to end execution, causing operation of the CAMMS-D software to terminate.

6 CAMMS-D Display Manager (DM)

Overview

The DM provides the user capabilities necessary to produce, display, manage, and analyze CAMMS-D TDAs, including capabilities to access and analyze digital terrain data. The following (Figure 29) is an illustration of the DM window.

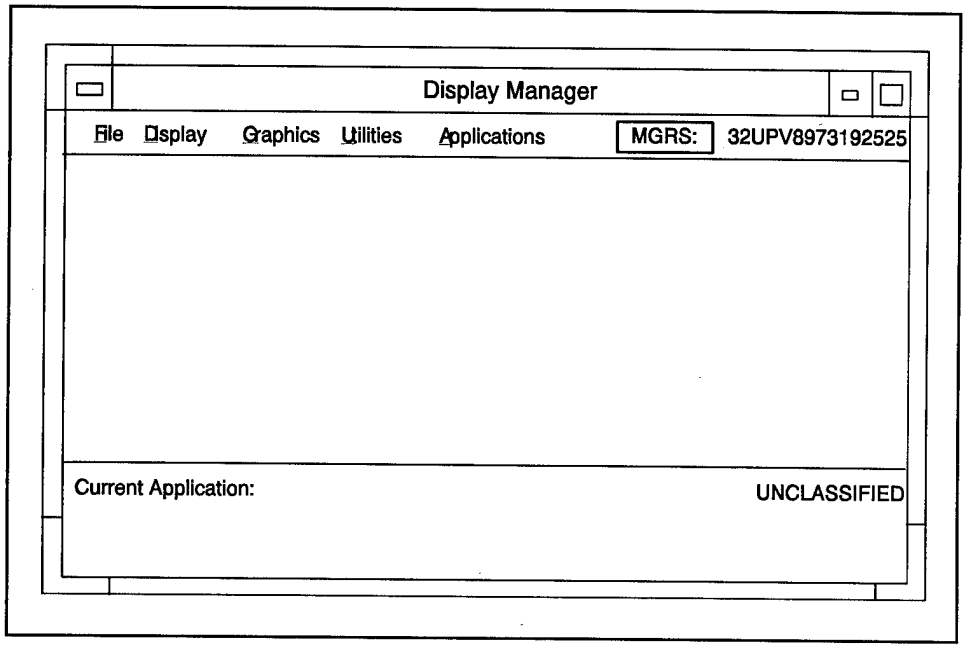

Figure 29. CAMMS-D Display Manager

The "Current Application:" notation in the lower left corner of the DM window indicates the application which is active (i.e.-- requesting input from the user via any one of the means described in Chapter 4). The DM main menu includes items "File", "Display", "Graphics", "Utilities", and "Applications", functions of which are described below.

File

Selection of "File" from the DM main menu produces a menu like that illustrated in Figure 30.

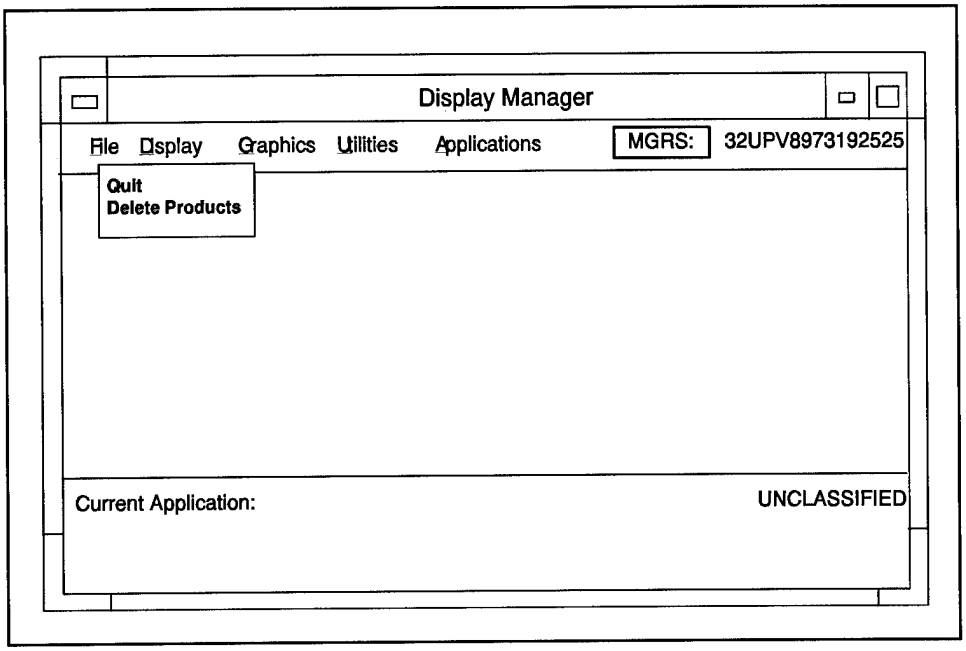

Figure 30. Display Manager "File" menu

Selection of "Quit" in the "File" menu will cause the DM window and all other associated windows (Map Control, Product Manager, Legends, etc.) to disappear. The user can then select from the CM window. Selection of "Quit" does not end execution of the CAMMS-D software; only the DM ends execution.

Selection of "Delete Products" in the "File" menu will cause a list of product types to appear similar to that illustrated in the window below (Figure 31).

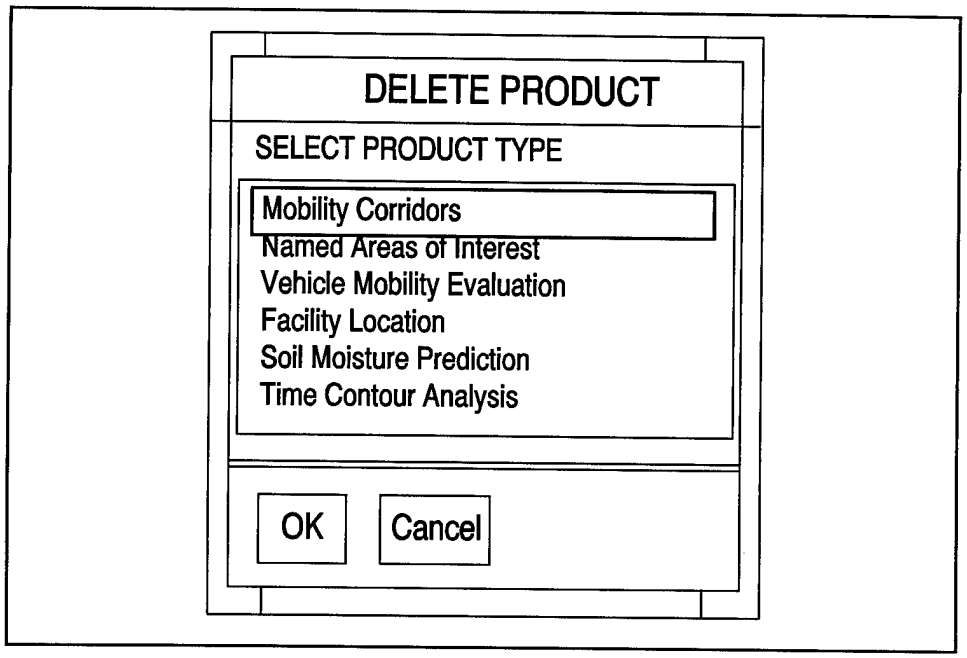

Figure 31. "Delete Products" list

The user should then highlight the product type (product category) from which products are to be deleted and press "OK". This action will cause a list of available products of that type (category) to appear. Products to be deleted should be highlighted; then, "OK" should be pressed. If no products are available for deletion, a message will appear indicating so.

Display

Selection of "Display" from the DM main menu causes the menu illustrated in Figure 32 to appear.

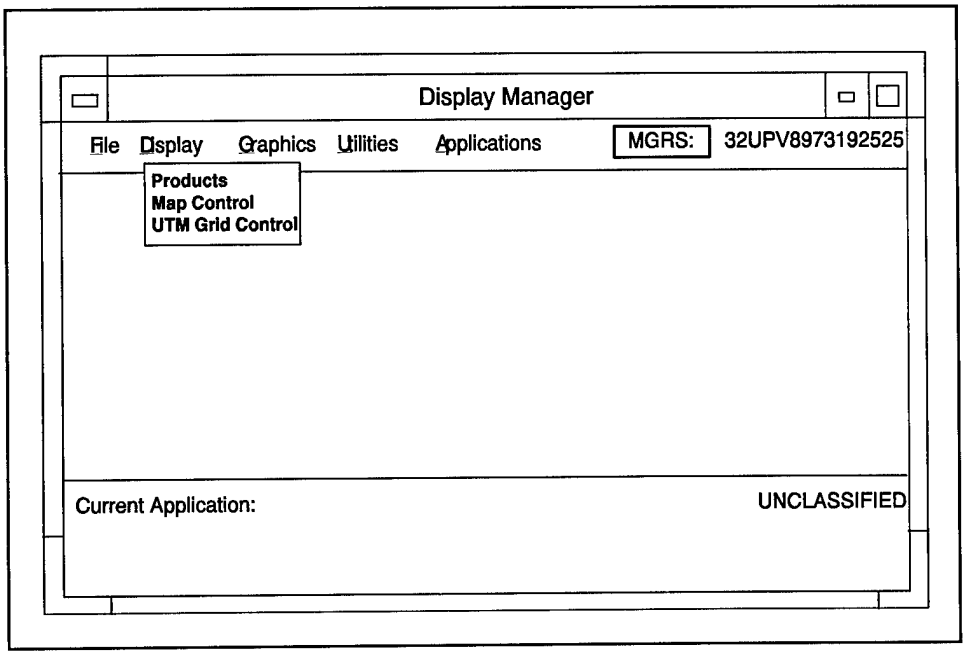

Figure 32. Display Manager "Display" menu

Capabilities of the items "Products", "Map Control", and "UTM Grid Control" from the above Display menu are discussed, in turn, in the following paragraphs.

Selection of "Products" from the "Display" menu provides access to the CAMMS-D Product Manager (PM). The PM allows the user to create a product, display one or more previously created products, and/or edit legend(s) associated with product(s). Details on the PM are provided in Chapter 8.

Selection of "Map Control" from the "Display" menu allows the user to control the display of background image maps and product overlays. "Map Control" also allows the user to adjust the scale of image maps and product overlays (zoom-in or zoom-out), to select the desired center of a map, and to pan (move) vertically or horizontally. For an image map, the user can select the type of map to be displayed, select whether to display the map in color or in shades of gray (gray scale), and adjust the intensity of the map. Image maps available within CAMMS-D are the Topographic Line (TL) map (1:50,000 scale), Joint Operation Graphic - Ground (JOG-G) map (1:250,000 scale), Joint Operation Graphic - Air (JOG-A) map (1:250,000 scale), Tactical

Pilotage Charts (TPC) map (1:500,000 scale), and the Operational Navigation Charts (ONC) map (1:1,000,000 scale). Examples of the image maps are provided on the following pages in Figures 33 - 37.

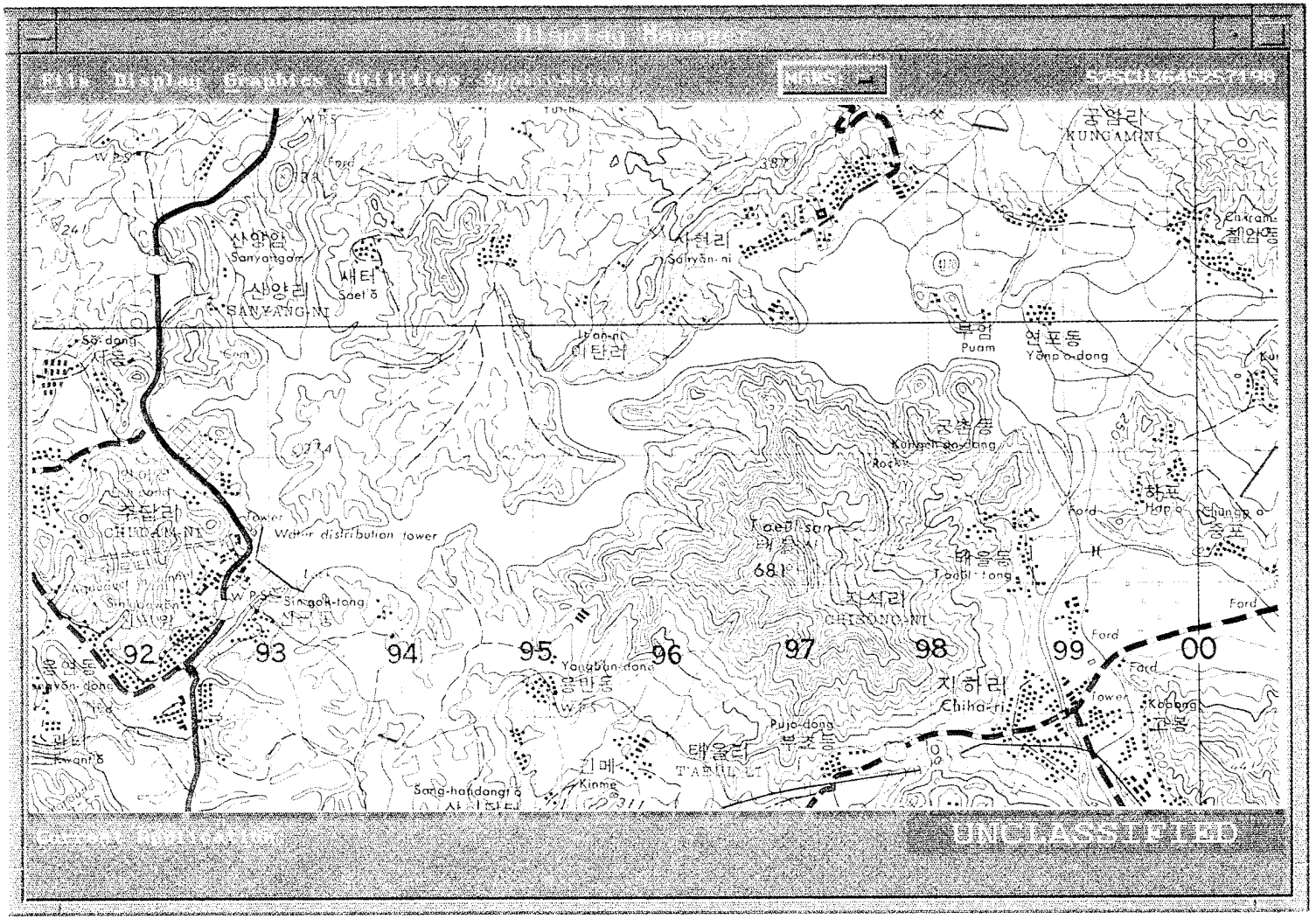

Figure 33. Sample topographic line (TL) background map (1:50,000)

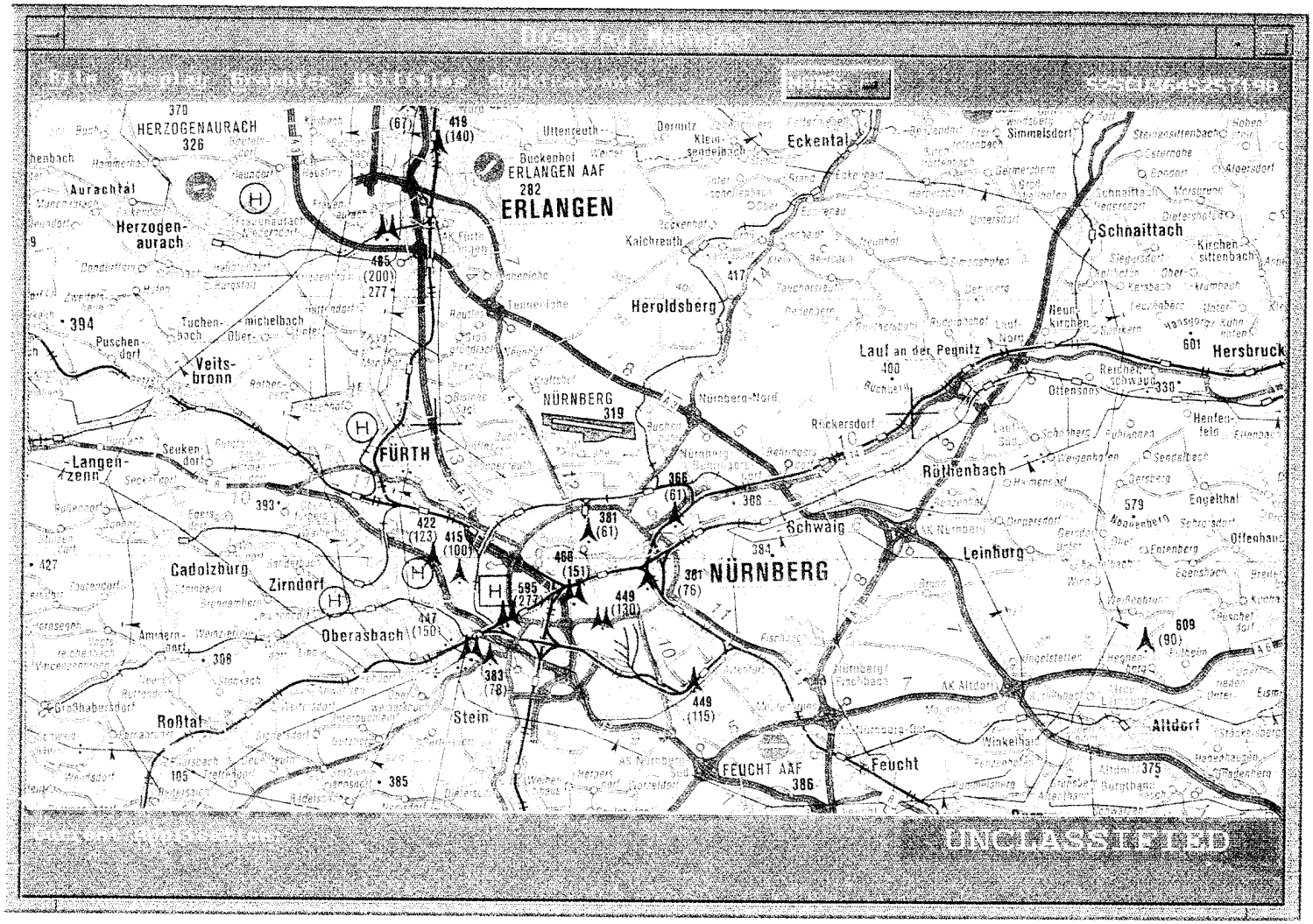

Figure 34. Sample joint operation graphics - ground (JOG-G) background map (1:250,000)

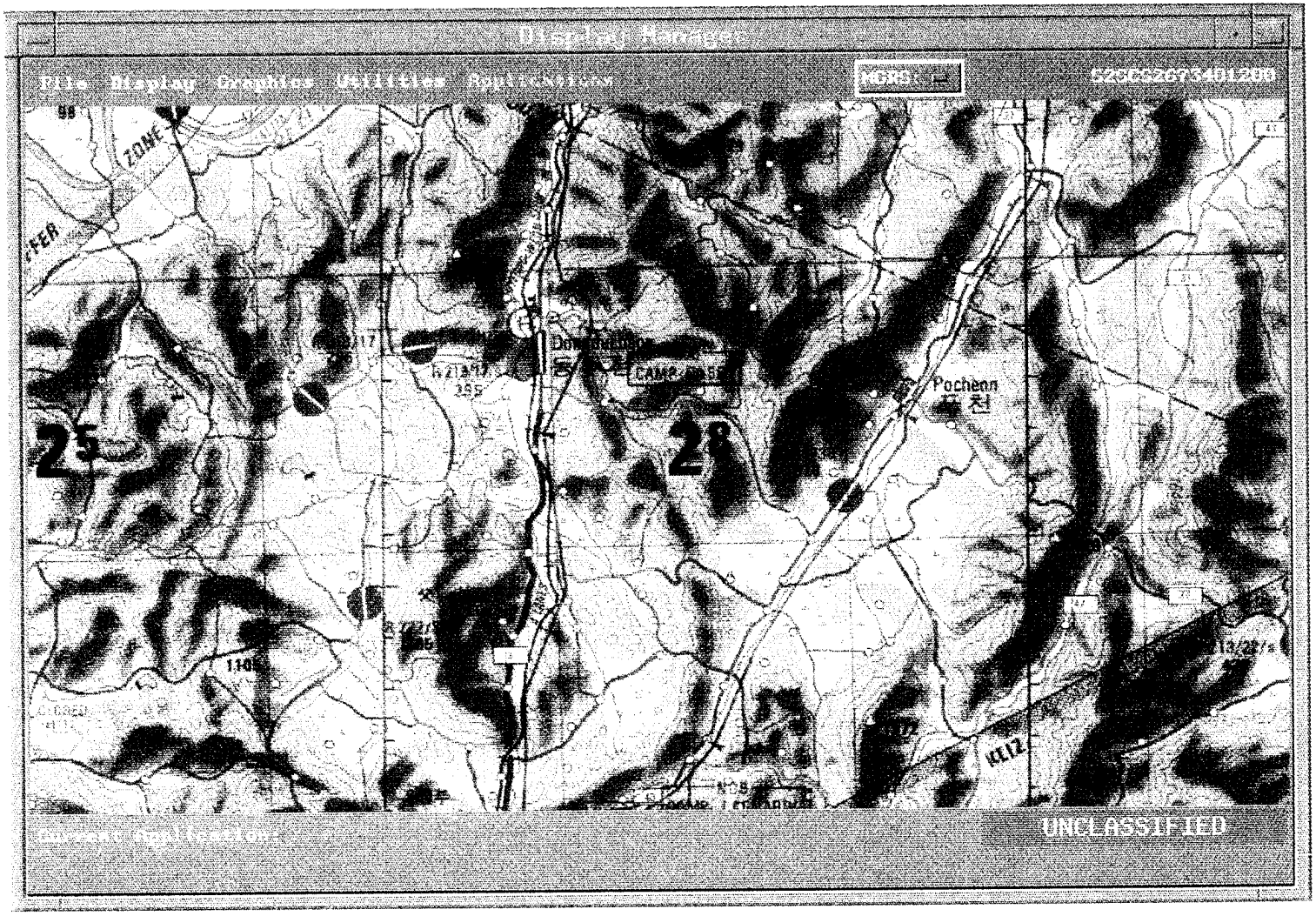

Figure 35. Sample joint operation graphics - air (JOG-A) background map (1:250,000)

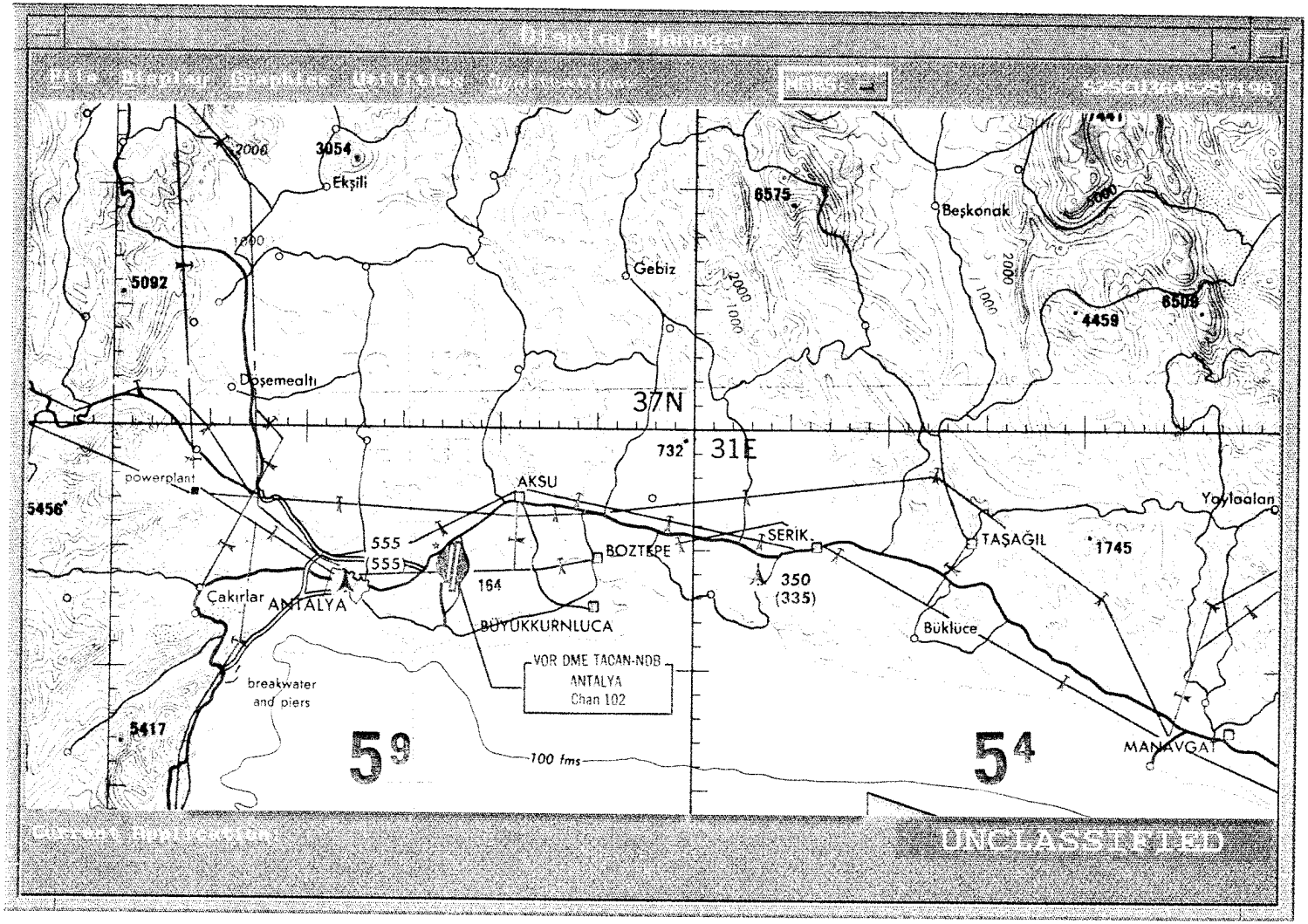

Figure 36. Sample tactical pilotage charts (TPC) background map (1:500,000)

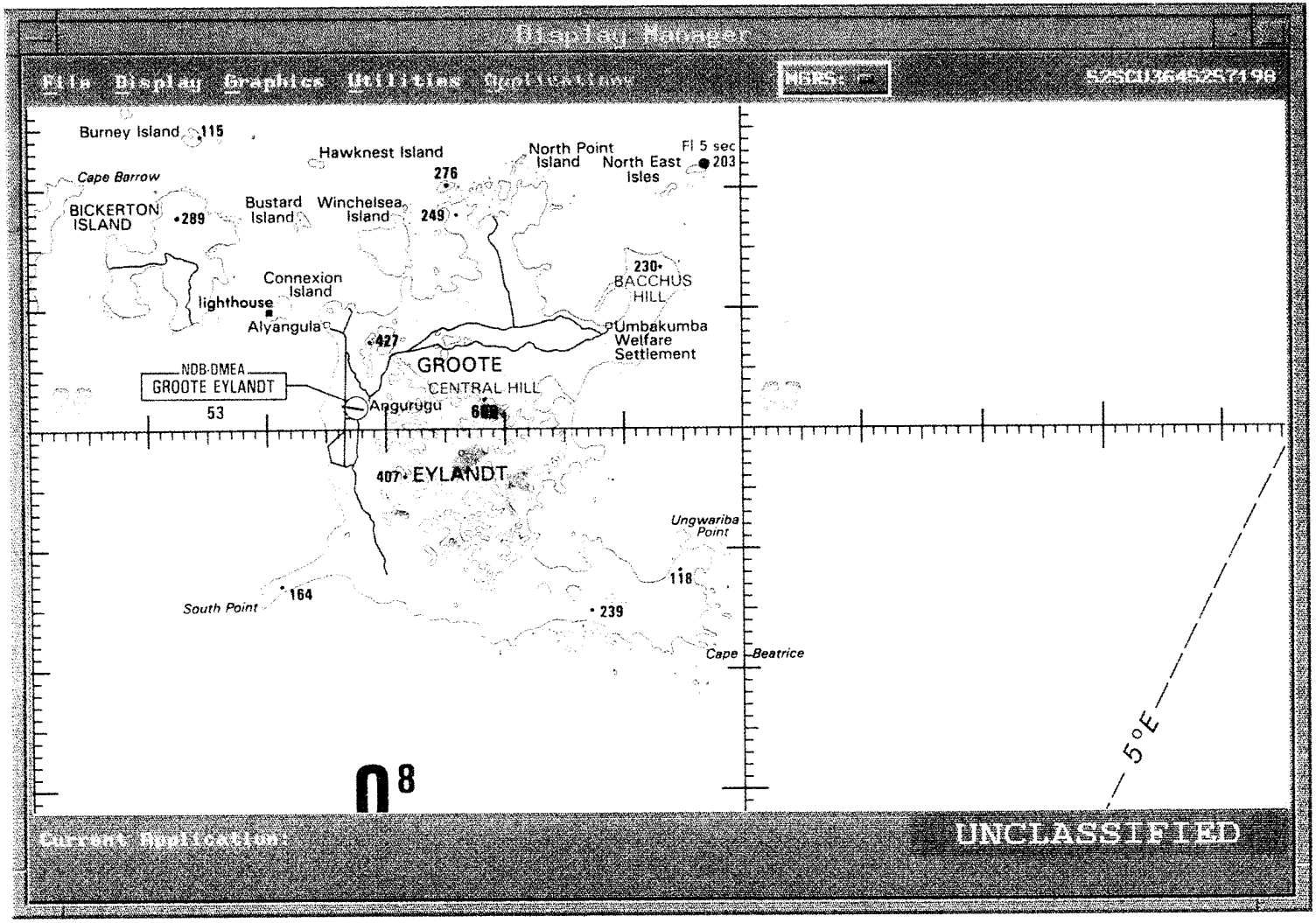

Figure 37. Sample operational navigation charts (ONC) background map (1:1,000,000)

Figure 38 illustrates the Map Control form, from which the user can perform the functions described in the preceding paragraph. Each element within the form is defined within the illustration.

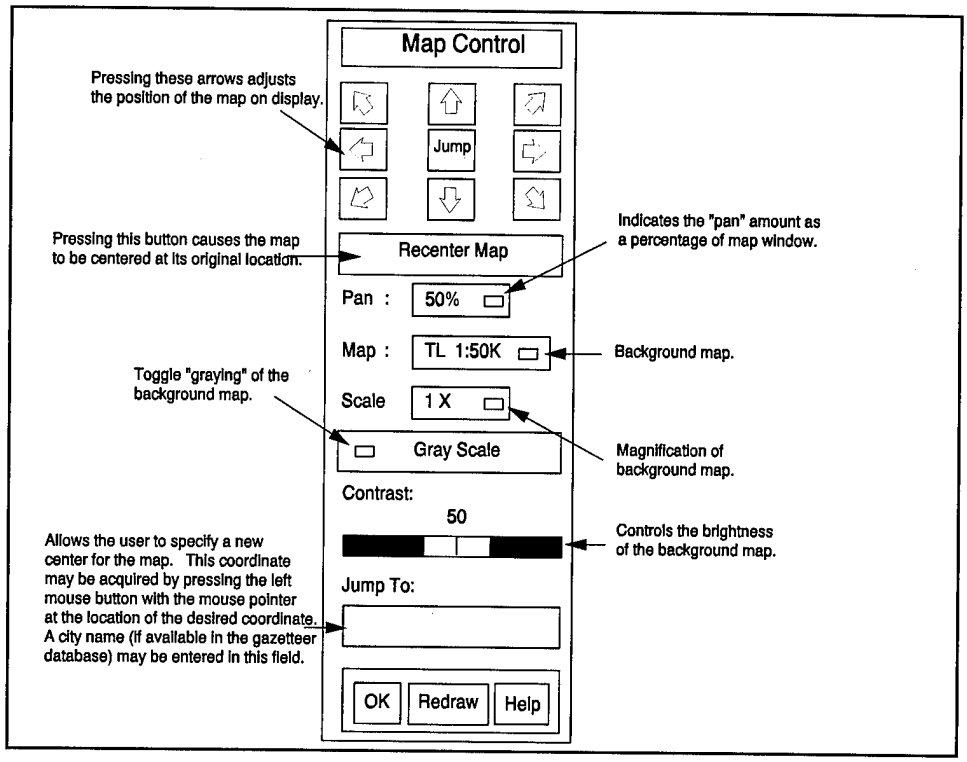

Figure 38. Map Control form

Selection of "UTM Grid Control" in the "Display" menu allows the user to control the plotting of UTM grid lines. When this option is selected, the form illustrated below in Figure 39 will appear. The purpose of each item in the form is described in the illustration.

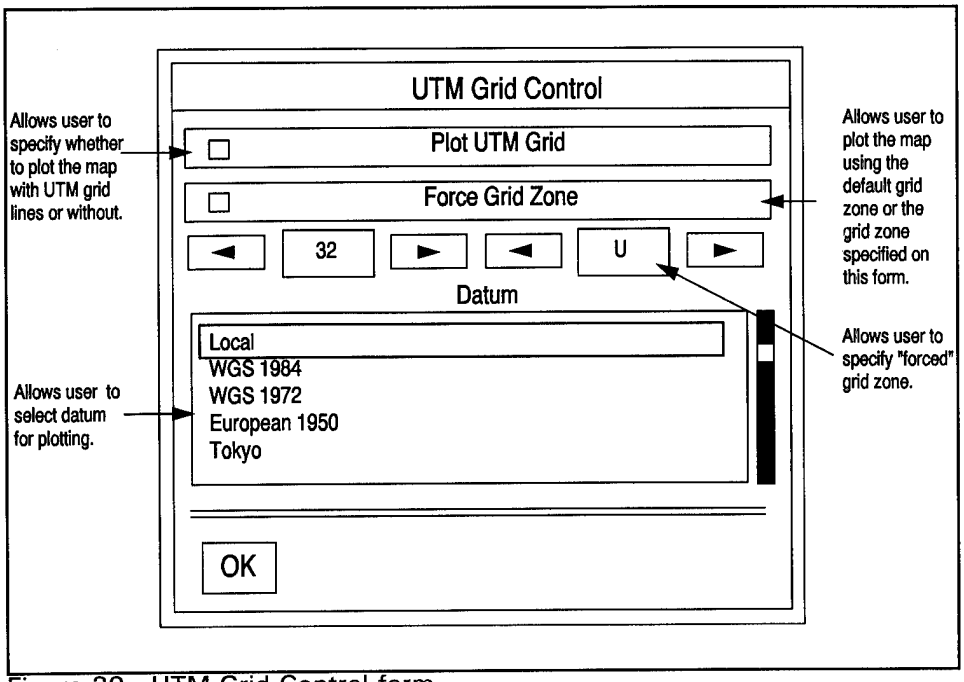

Figure 39. UTM Grid Control form

Pressing "OK" will save the changes made to the above form.

Graphics

Selection of this option from the DM main menu allows the user to display a legend of the active CAMMS-D products; to create a three dimensional (3-D) perspective view of a displayed product overlay, or image map; to produce a "hard copy" of an overlay or a portion of an overlay; and to view small portions of a displayed overlay map through a "magnifying glass". Figure 40 illustrates the Graphics menu.

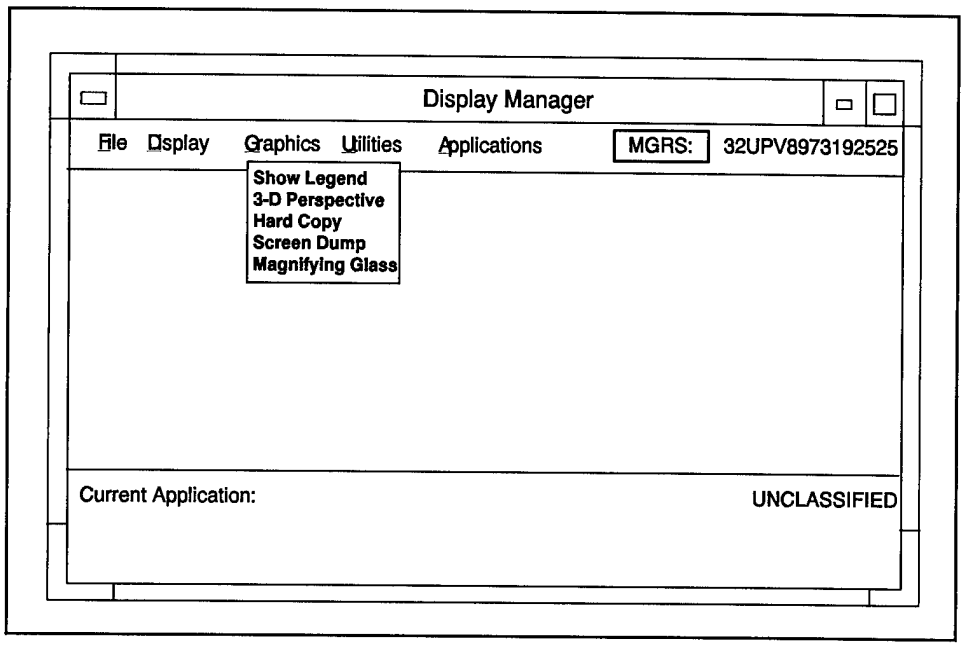

Figure 40. Display Manager "Graphics" menu

Each item in the "Graphics" menu is discussed in the following paragraphs.

Selection of the "Show Legend" option on the "Graphics" menu causes a legend to be displayed for the active products. If no products are active, no legend will appear. A legend window, as with most X-Windows, may be resized or moved to another location on the screen. To remove the legend from the screen, the user should press "OK".

Selection of the "3-D Perspective" option on the "Graphics" menu allows the user to create a 3-D view of the active product overlays and/or image maps. When this option is selected, the user will be prompted to select an observer's location and viewing direction. This is accomplished by moving the mouse pointer to the desired location on the map and then depressing the left mouse button. The user must continue to hold the mouse button to "stretch the thread" and thereby indicate the observer's correct viewing direction; the user should then release the left mouse button. A form like that illustrated below in Figure 41 will then appear requesting information concerning the 3-D perspective view.

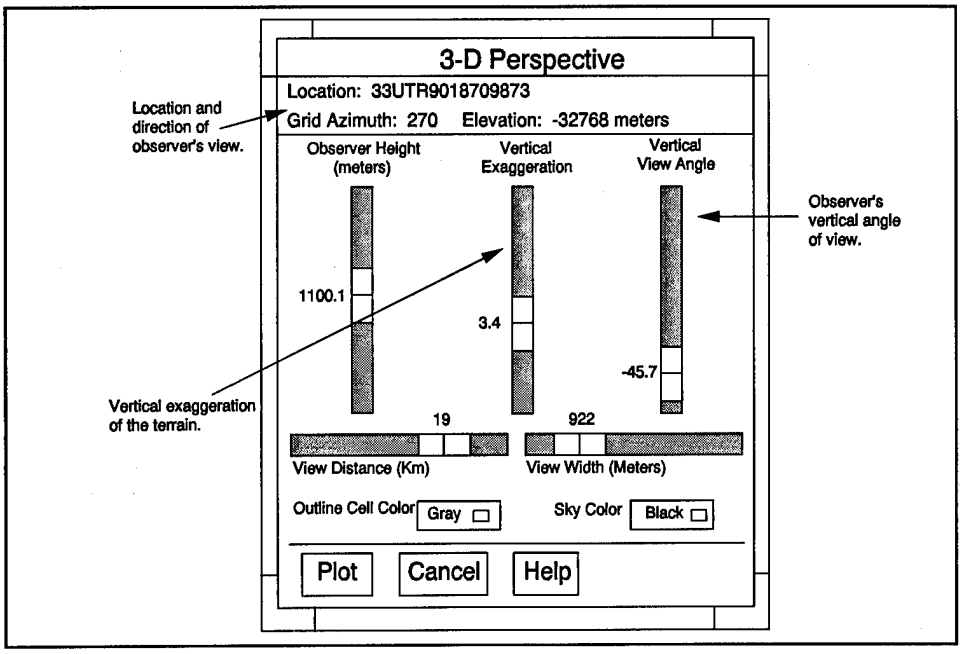

Figure 41. 3-D Perspective form

When the form is completed, the user should press "OK" to begin plotting the 3-D perspective view. Two buttons are included on the "3-D Perspective" window, "OK" and "Modify". Pressing "OK" will cause the 3-D Perspective view to terminate; pressing "Modify" will allow the user to alter the information specified on the form without changing the observer's location and viewing direction. If the user wishes to change the observer's location, it is necessary to terminate the 3-D Perspective window (by pressing "OK") and to reselect the 3-D Perspective option from the "Graphics" menu. A sample 3-D perspective is provided in Figure 42.

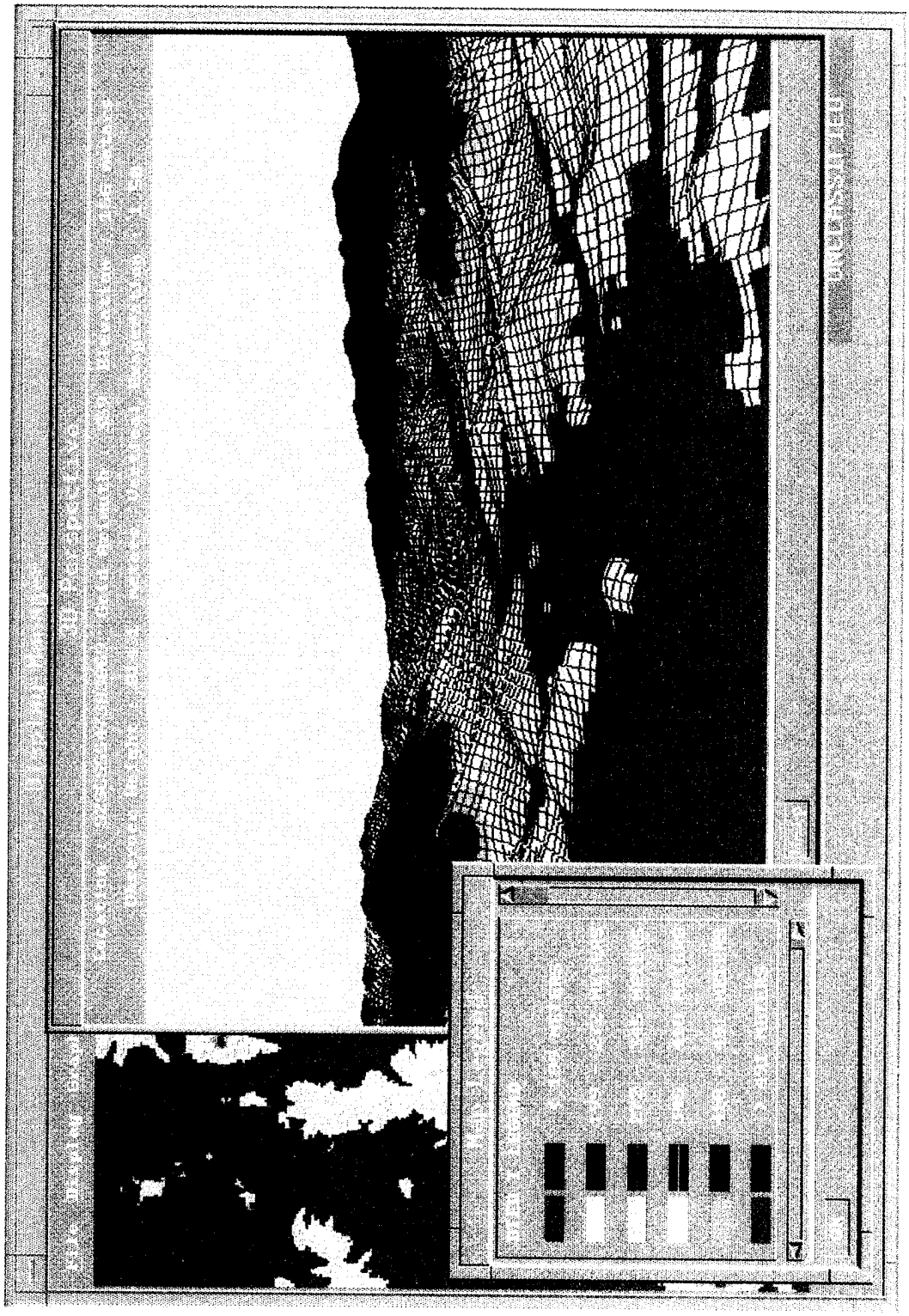

Figure 42. Sample 3-D elevation perspective

Selection of the "Hard Copy" option allows the user to produce to scale a hard copy (paper copy) of a CAMMS-D overlay. Upon selection of this option, the user will be prompted by the form illustrated below to provide information concerning the hard copy to be printed. Each item in the form is described in Figure 43.

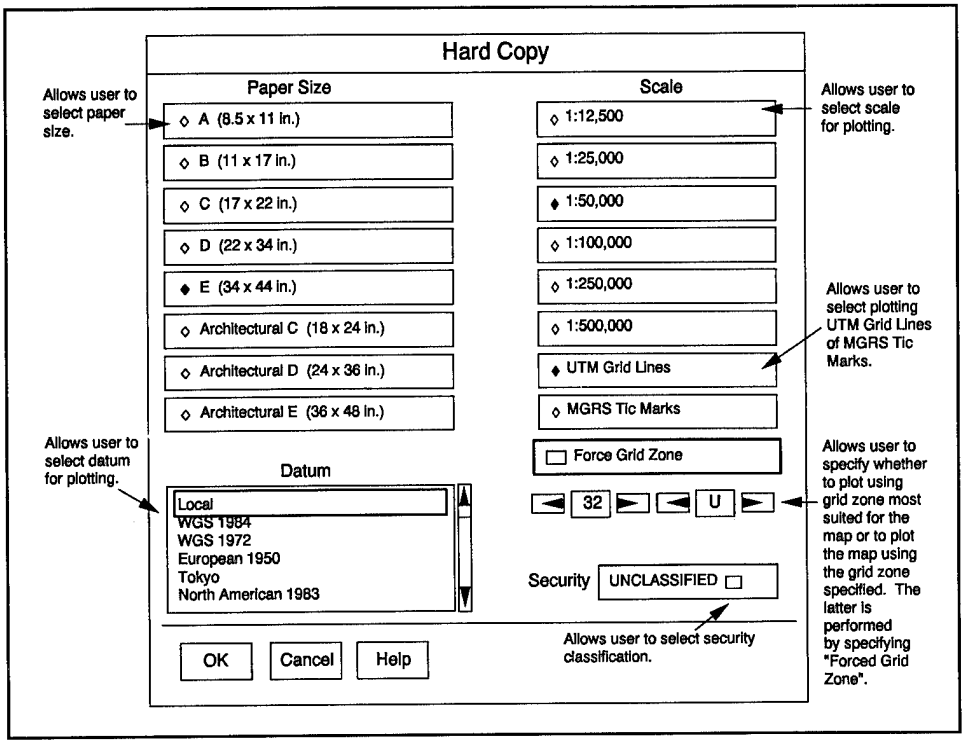

Figure 43. "Hard Copy" form

Once all fields in the form have been completed, the user should press "OK" which will begin the printing process.

Selection of the "Screen Dump" option on the Graphics menu allows the user to dump (print) the image (CAMMS-D TDAs, image maps, etc.) that are on the computer screen onto paper or transparent media. This Graphics utility differs from "Hard Copy" since it does not allow the user to produce a hard copy to scale; only a "photo" of the screen is produced. This utility requires an HP Paint Jet XL300 connected to the CAMMS-D computer. Upon selection of "Screen Dump", the following form (Figure 44) will appear.

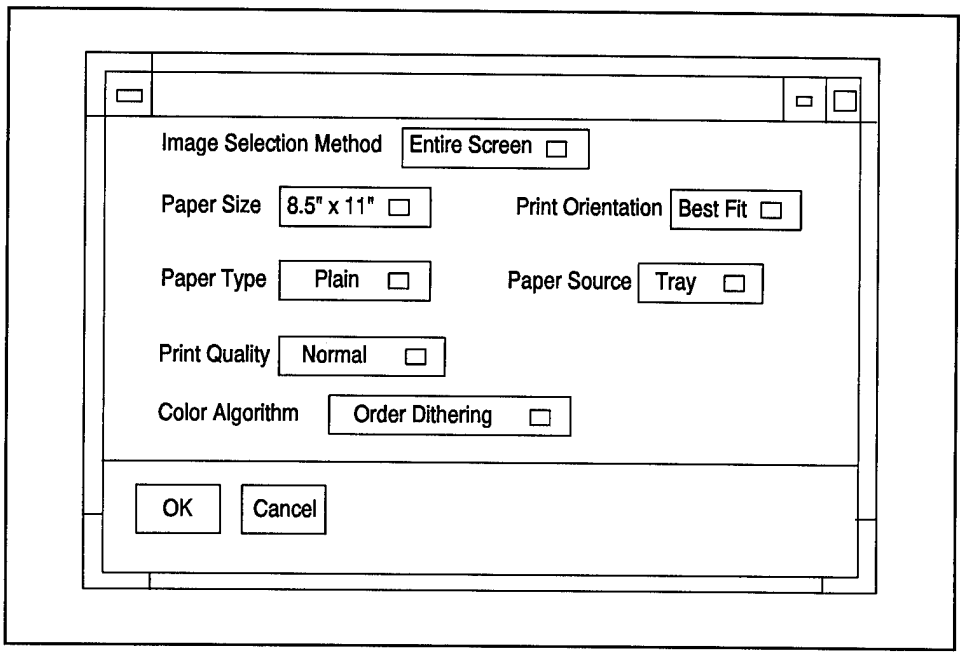

Figure 44. "Screen Dump Utility" form

The user must set the various parameters (paper size, paper type, paper source, etc.) before continuing with the printing (dump) utility. These parameters are described below.

a. *Image Selection Method* - Refers to the method to be used in specifying the image to capture. The user can choose to print the entire screen, a user-selected window, or a user-selected box.

b. *Paper Size* - Refers to the dimensions (in inches) of the paper to be used for printing. Paper sizes supported by CAMMS-D are 8.5 in. x 11 in., 8.5 in. x 14 in., and 11 in. x 17 in.

c. *Paper Type* - Refers to the type of paper on which the print will be made. The paper (or media) types supported by CAMMS-D are plain paper, bond paper, HP special paper, glossy film, and transparency.

d. *Print Quality* - A direct relationship exists between the time required to produce the print and the quality of the print. Faster printing produces lower quality prints, slower printing produces higher quality prints. The CAMMS-D software allows the user to choose between "Fast", "Normal", or "Presentation" (slowest) print quality.

e. *Color Algorithm* - The HP Paint Jet provides several algorithms for converting the screen image to a "printable" format. The user is provided the following algorithms from which to choose.

(1) Order Dithering

(2) Error Diffusion

(3) Clustered Ordered Dithering

(4) Monochrome Ordered Dithering

(5) Monochrome Clustered Dithering

No further explanation of these various algorithms is provided by the manufacturer. The user should experiment with these options to determine which works best for a particular screen dump.

f. *Print Orientation* - Refers to the orientation of the image relative to the media (paper, film, etc.). The user can select from best fit, portrait, or landscape. Best fit instructs the software to select the orientation (portrait or landscape) which best suits the image. These orientations are described in Figure 45.

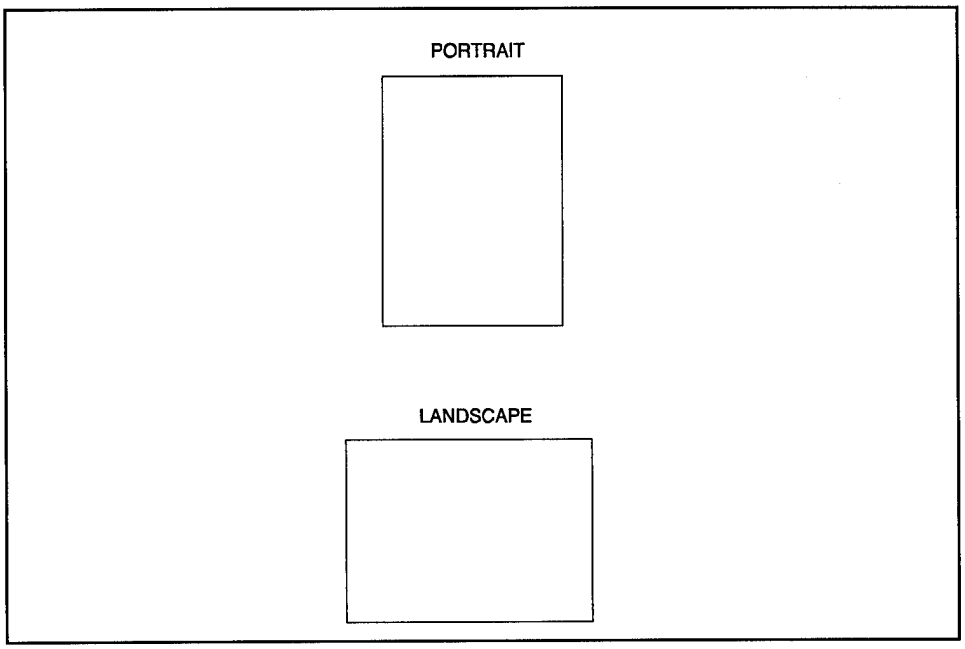

Figure 45. Comparison of portrait and landscape orientations

g. *Paper Source* - The user can select the source from which paper (media) will be provided to the printer. The user may select "Tray" to instruct the printer to retrieve a sheet of media from the tray; if "Manual" is selected, the user must place the media, one sheet at a time, into the slot for manual feed on the printer.

In using the "Screen Dump" option on the "Graphics" menu, the user should experiment to determine what settings work best for a specific image. For example, the user might find that if a background map is to be plotted, an intensity setting of "60" would produce the best image map.

Selection of the "Magnifying Glass" option on the "Graphics" menu allows the user to view through a "magnifying glass" the map or overlay displayed on the screen. When this option is selected, the user should first select a point on the map by using the mouse cursor. Once a point is selected, a small window will appear containing the magnified view.

Utilities

Selection of this option from the DM main menu will cause the Utilities menu to be displayed. This menu allows the user access to the utilities "Data Point Query", "Compute Surface Distance", "Compute Surface Area", and "Display AOP" as described in the following paragraphs.

The "Data Point Query" option in the "Utilities" menu is the first step in allowing the user to obtain detailed information concerning any user-specified point on the map. Upon selection of this option, the user will be prompted by the form illustrated in Figure 46 to select the user's feature(s) of interest (transportation, drainage, etc.).

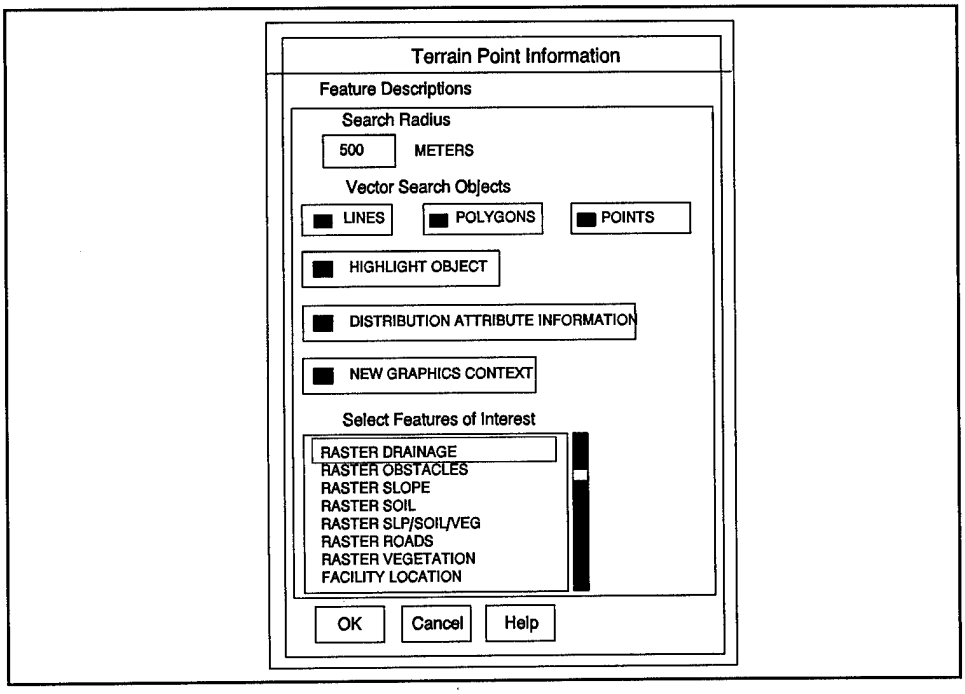

Figure 46. "Terrain Point Information" form

When all desired features have been highlighted, the user must press "OK". For each feature selected, the user must next select the attributes of interest. For example, if the user selected drainage as a feature, available attributes may include bank angle, water depth, water speed, bank vegetation, soil type on banks, etc. A list similar to the following in Figure 47 would be used to accomplish this task.

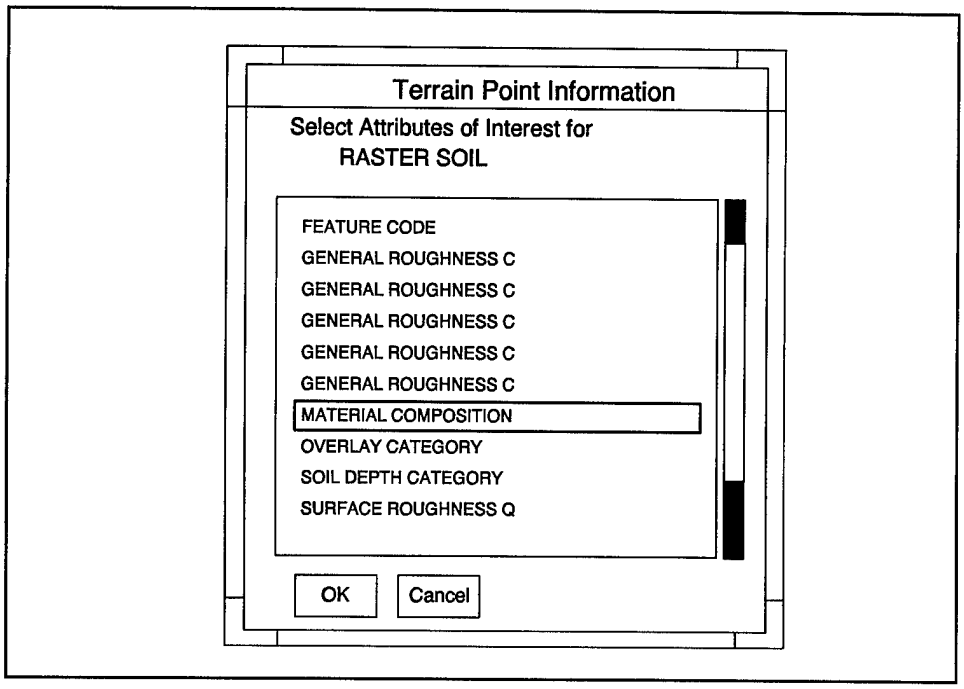

Figure 47. "Terrain Point Information" attribute list

When "OK" on the above form is pressed, the user will be prompted to select a point of interest on the map. This can be accomplished by moving the mouse pointer to the desired location and then "clicking" the left mouse button. The requested feature and attribute(s) will be displayed on a scrollable window. The user may continue selecting points on the map. When all points of interest have been selected, the user must press "Cancel" in the lower right corner of the CAMMS-D DM window.

The "Compute Surface Distance" option in the "Utilities" menu should be selected to allow the user to specify the line for which surface distance will be calculated. Surface distance refers to the "over ground" distance of the line drawn by the user. The user will be requested to select points representing the line of interest, which must consist of at least two, and no more than 50 line segments. The user does this by first moving the mouse pointer to the location of the first point and "clicking" the left mouse button, and then continuing this operation sequentially for all points on the line. "OK" should then be pressed to end the input of the points. The aerial distance and the surface distance of the line will both be displayed. The user should press "Cancel" to end execution of this utility.

Selection of the "Compute Surface Area" option in the "Utilities" menu allows the user to select an area for which the surface area will be computed. The user will next be requested to input the points of a polygon to represent the area of interest (at least 3 points, no more than 50). To input each point, the user should move the mouse pointer to the location of the point and click

the left mouse button. "OK" should then be pressed to end the input of points. The surface area of the polygon will be displayed. The user should then press "Cancel" to end execution of this utility.

Selection of the "Display AOP" option in the "Utilities" menu allows the user to graphically display the area of operation (AOP) boundaries, and to display a text window indicating the AOP description (name), local datum, and coordinates of the northeast and southwest corners of the AOP. A sample text window containing this information is illustrated in Figure 48.

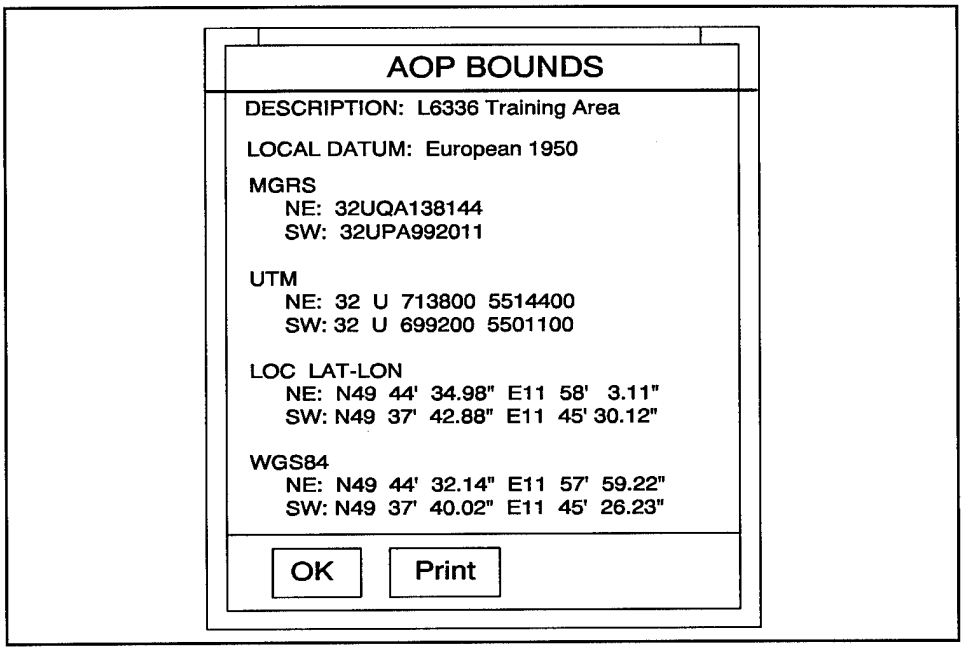

Figure 48. "AOP Bounds" sample text window

The AOP coordinates are displayed in four systems: Military Grid Reference System (MGRS), Universal Transverse Mercator (UTM), Local Latitude-Longitude, and World Geodetic System 1984 (WGS84). The only user inputs required are a line color and line type for displaying the AOP boundary.

Applications

Selection of this option from the DM main menu allows the user to select from a list of all presently executing applications. Selecting an application in this list makes it the active application--i.e., the application which is currently requesting input from the user. Figure 49 illustrates a list of currently executing applications.

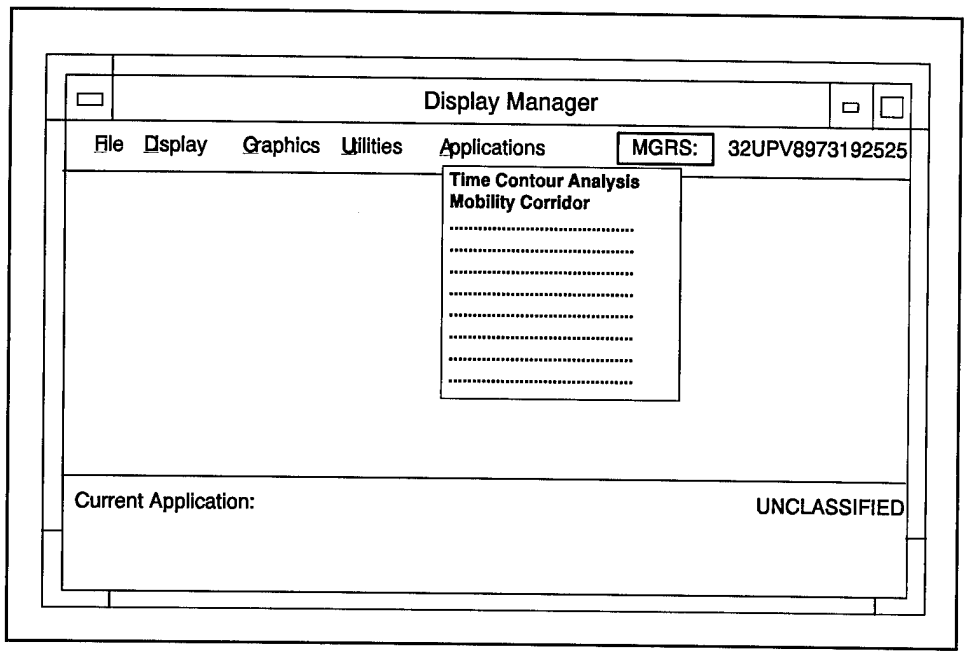

Figure 49. Example Display Manager "Applications" list

In the above list, notations consisting of dots (". . .") represent "vacancies" in the list.

7 CAMMS-D Product Manager (PM)

Select, Edit, and Create Capabilities

The CAMMS-D PM allows the user to control a number of operations within the various individual CAMMS-D TDAs, as described within Chapters 8 through 18 of this user's guide. The following paragraphs provide a more general description of CAMMS-D PM capabilities, beginning with the illustration below (Figure 50) of the CAMMS-D PM window.

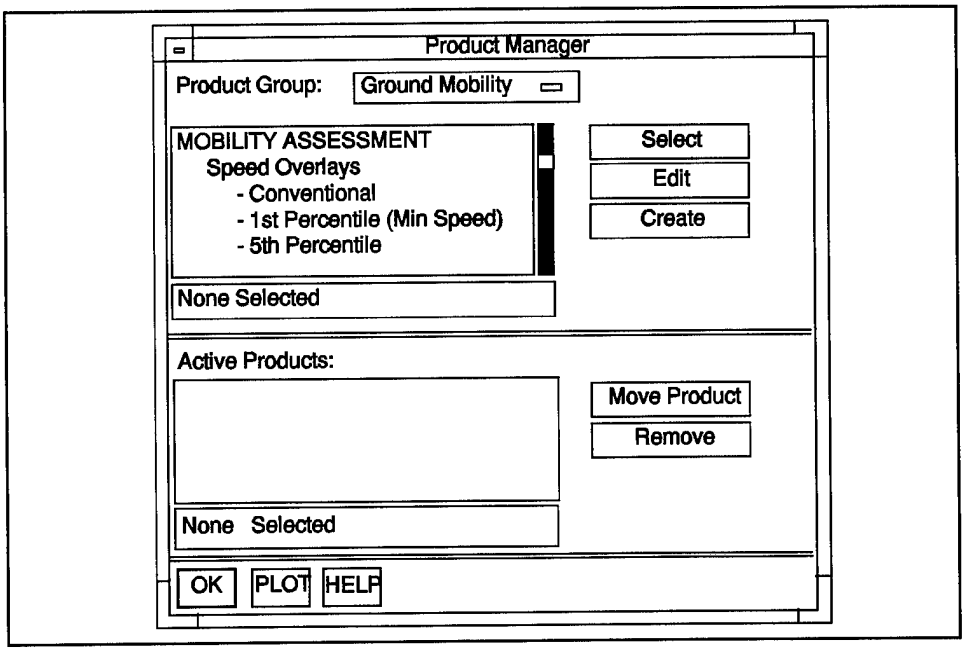

Figure 50. Product Manager Window

By using the above PM form, the user can define which TDAs will be selected, edited, and/or created. Capabilities provided by the use of these buttons are described as follows.

Select

Allows the user to select one or more TDA products for plotting. For example, when a product in the product list is highlighted and the select button is pressed, the product will appear in the active product list. All selected products will be plotted on the computer screen. (When more than one product is selected, the products will plot overlying one another.) After a given product is plotted and the user has no further need of it, the user should return to the Product Manager form and remove this product from the list of active products. This is accomplished by highlighting the product of concern in the active products list and pressing "Remove".

Also, a product included in the active product list can be repositioned within the list by performing the following steps:

a. Highlight the desired product in the active product list.

b. Press "Move Product".

c. Move the pointer to the desired location in the list and click the left mouse button.

Edit

Allows the user to edit the legend associated with the user-highlighted product.

Create

Begins execution of the highlighted product. For example, if "Edit Weather Gauges" were the product highlighted in a product list, the executable which performs this task would begin executing when "Create" is pressed.

Some of the above buttons are deactivated for certain TDAs. For example, for the TDA product "Edit Weather Gauges" no legend is used and no "Edit" capability is needed; therefore, "Edit" would be deactivated and appear only faintly on the PM form when the "Edit Weather Gauges" option is highlighted. A second example involves those TDAs whose contents are pre-produced by the CAMMS-D software and whose use requires no execution as allowed by the "Create" option. An example of such a TDA is the BTF Elevation (DTED Level I) TDA within the TERRAIN FACTORS TDA Category; for this TDA, "Create" would be deactivated and appear only faintly on the PM form.

Utilization of the PM "Select" and "Create" capabilities is straightforward and does not require a detailed description beyond that provided above for "Select" and "Create". The PM "Edit" capability, which allows the user to

edit the legends of many of the CAMMS-D TDA products, promotes the user's ability to tailor those TDAs to particular real-world situations. Utilization of this valuable capability sometimes requires several steps, as described and illustrated under the following heading.

Editing TDA Legends Capabilities

On the CAMMS-D PM window, when a product is highlighted and "Edit" is activated (bold), the user can edit the legend. In Figure 51, the highlighted product is "BTF Land Classification".

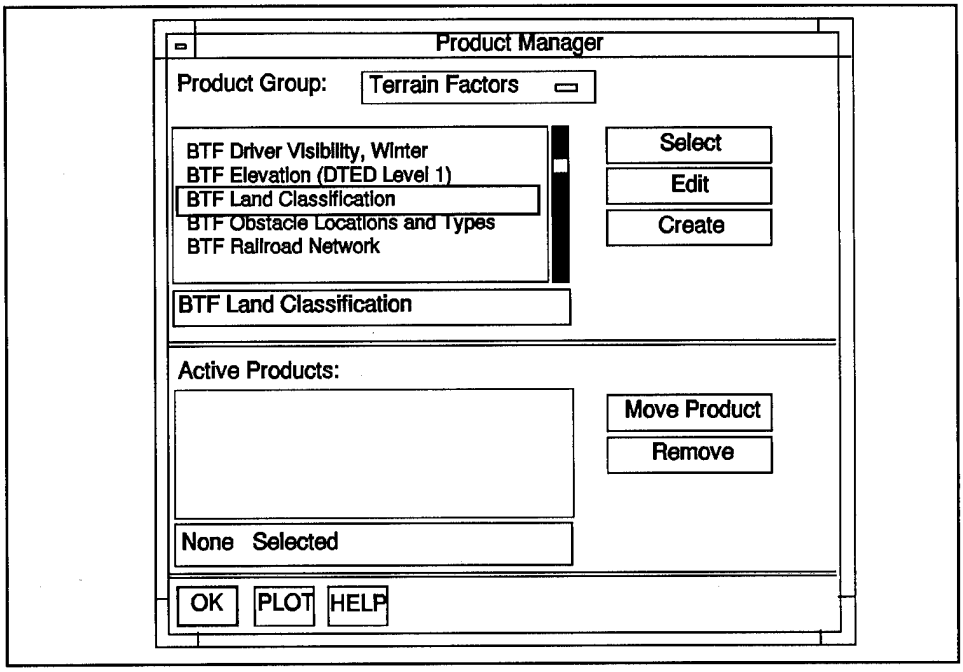

Figure 51. Product Manager Window with selection for legend editing

The following examples illustrate several aspects of editing legends of CAMMS-D TDA products.

Example 1

With the CAMMS-D DM running, select "Display" from the DM main menu, as illustrated below in Figure 52.

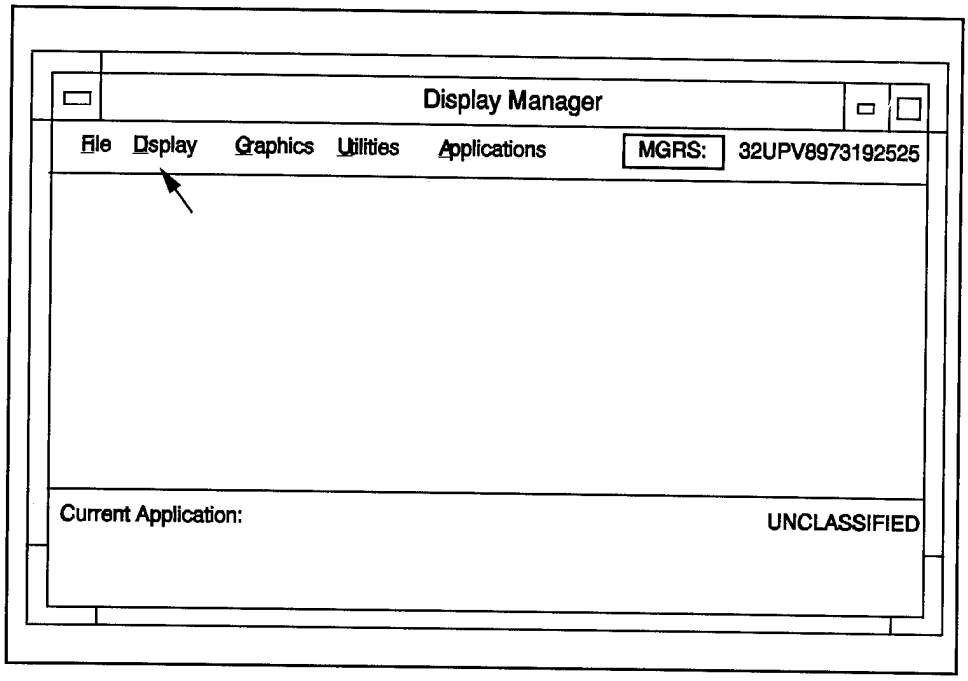

Figure 52. Display Manager Window

This will cause the following menu to appear. Select "Products" as illustrated in Figure 53.

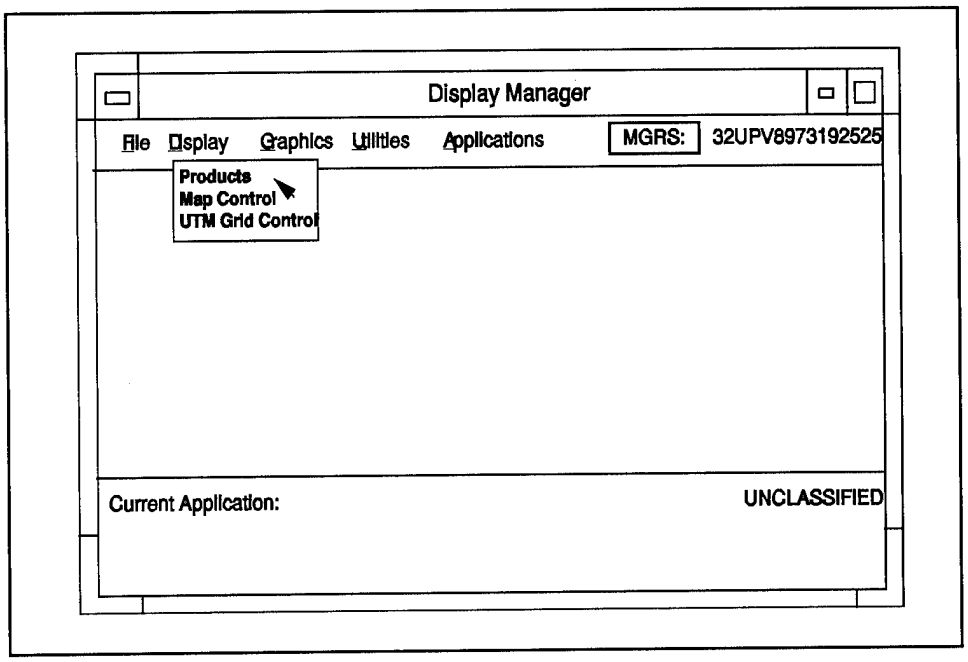

Figure 53. Display Manager "Display Window"

This will cause the Product Manager to appear, illustrated as follows. Press the selected Product Group to obtain a list of the available product groups (categories) illustrated in Figure 54.

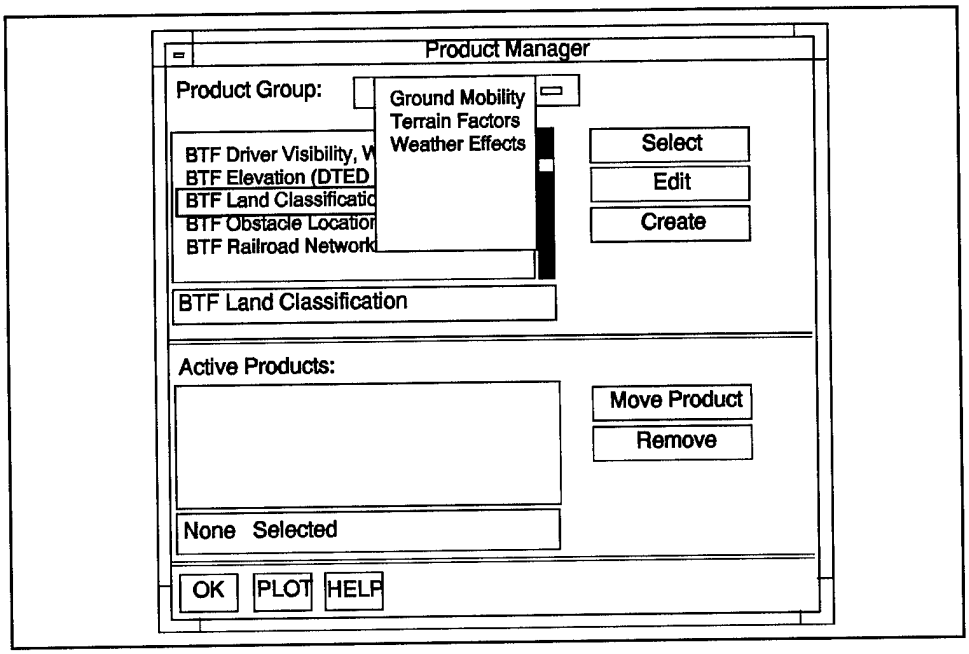

Figure 54. Product Manager with product group list

This action will produce the following list (Figure 55) from which the desired product (TDA) should be selected.

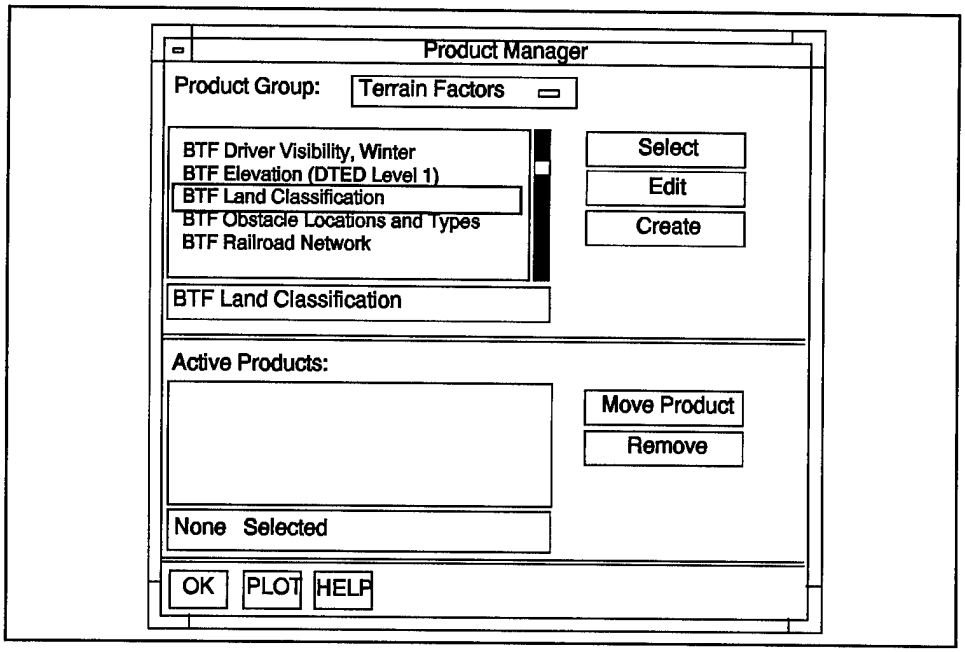

Figure 55. Product Manager window

The available product groups (or categories) are Ground Mobility, Terrain Factors, and Weather Effects. Highlight the product of interest within the listing and press "Edit" as shown in Figure 56. (Note: If "Edit" shows only faintly, it is deactivated; therefore, no edit is allowed.)

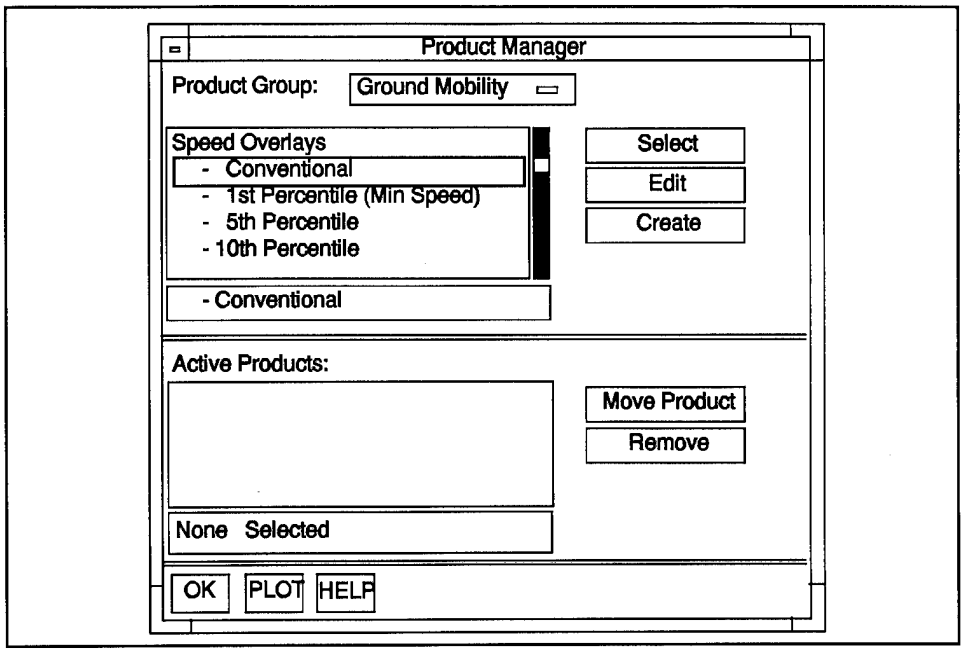

Figure 56. Product Manager with selection for legend editing

Pressing "Edit" for an editable product may cause another menu to appear shown in Figure 57. If this occurs, make the proper selection from the menu, illustrated as follows for the above situation.

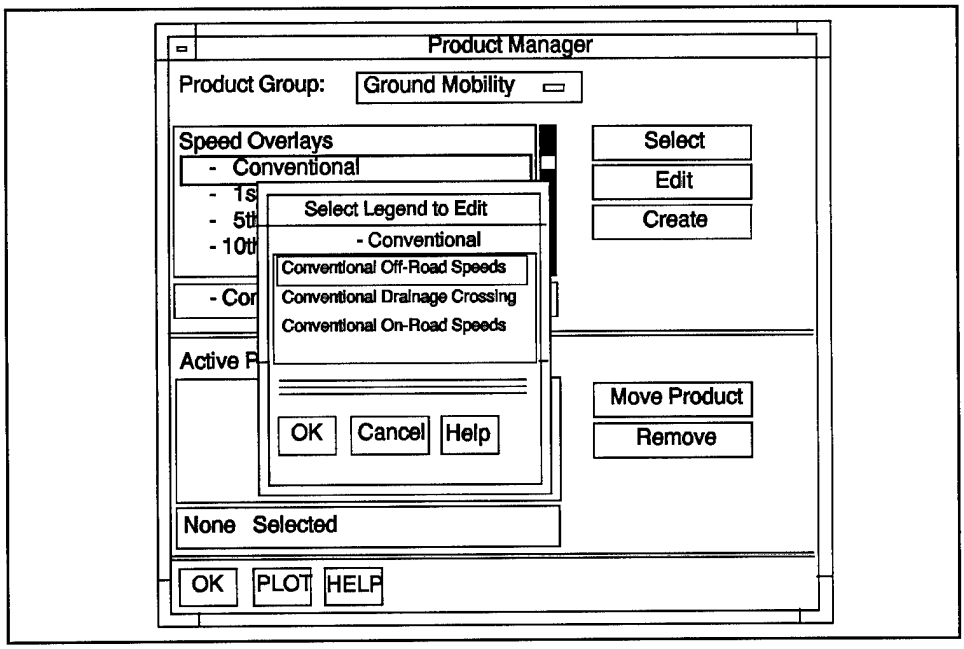

Figure 57. Legend selection menu

Example 2

This example of a legend editor window is associated with a TDA product that deals with data having discrete values, illustrated in Figure 58.

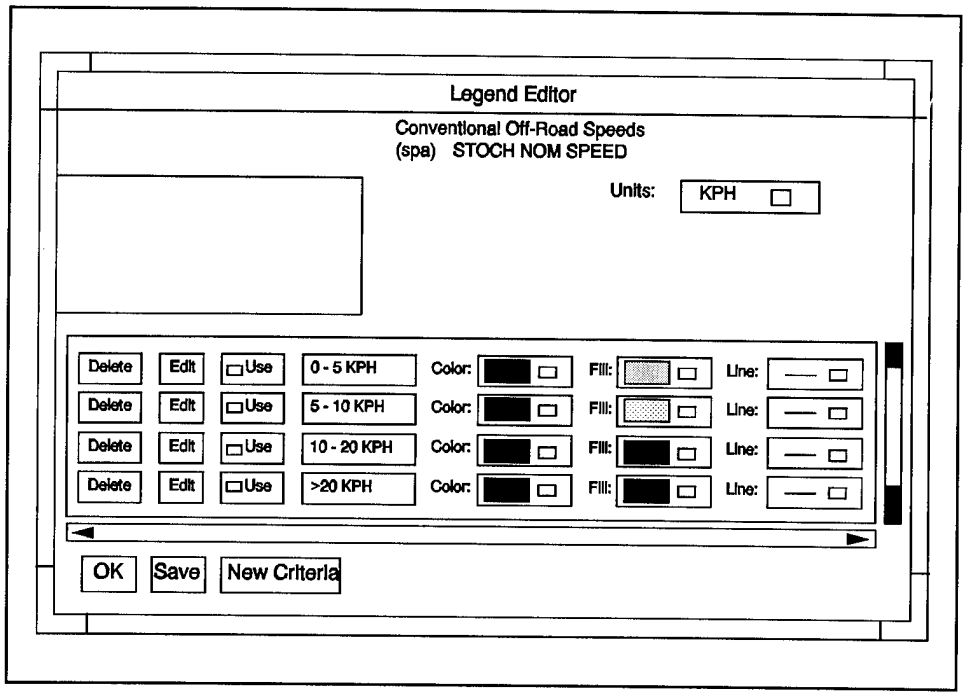

Figure 58. Legend editing form

Each line in the above window represents one category (range) of data. If new categories are to be addressed, press "New Criteria".

An existing data category can be edited by pressing "Edit" on that category's line. When this action is performed for the first category line, for example, the following screen results (Figure 59).

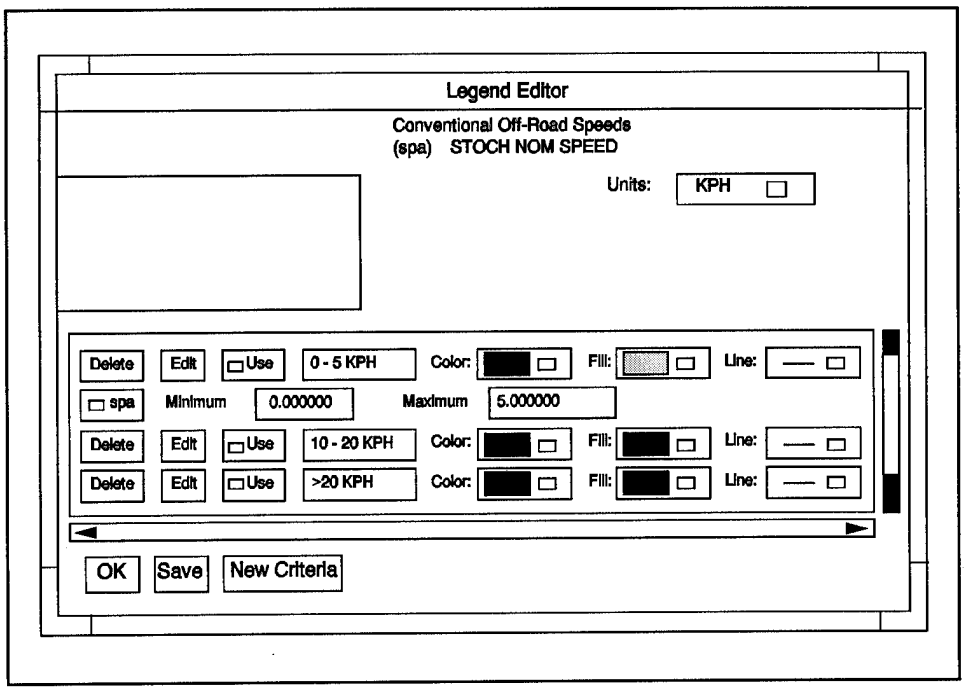

Figure 59. Legend editor form for altering minimum and maximum values

Results for using "Delete", "Edit", and "Use" in the above illustration are described as follows. The user can press "Delete" to delete a category (i.e., to delete the range of data which that category represents). The user can press "Edit" to alter the minimum and maximum values for a category. The user must assure that the "Use" switch is turned "on" for a category to appear on a legend.

The user can alter the color, fill, and line entries for a product by pressing the rectangle indicating the current selection of any of these entries. As long as the left mouse button remains depressed, a menu for each of these entries will be displayed. The user should then move the pointer to the color, pattern, or line desired, and release the left mouse button. Figure 60 illustrates how the window might look at this point.

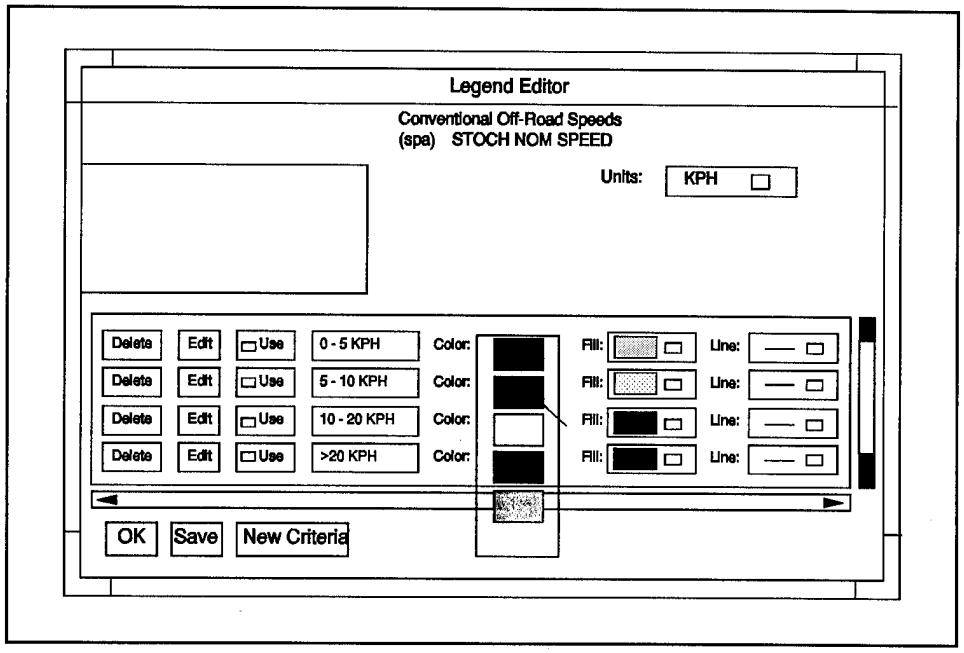

Figure 60. Legend editing form for altering color

"Save" must be pressed to save any changes made to the legend. Pressing "OK" causes an exit from the legend editor form.

Discrete data are defined by measurements in units (cm, degrees, etc.), which the user can alter by first pressing the rectangle showing the current unit of measurement, say "YARDS", as illustrated below. When this is done, a "pop-up" menu will appear (Figure 61). To change units, say from yards to meters, the user would then move the arrow to "METER" and click the mouse button.

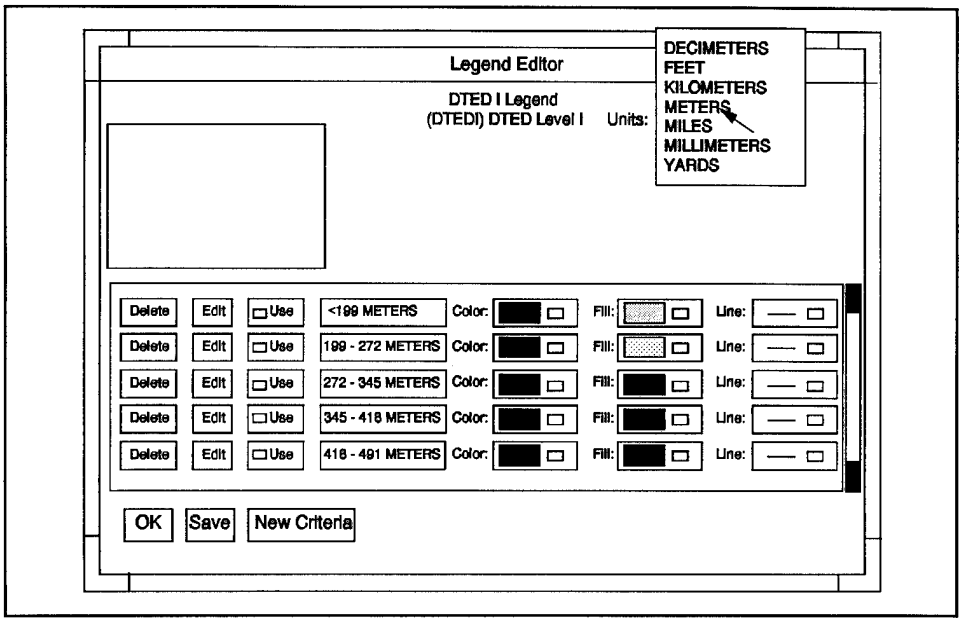

Figure 61. Legend editing form for altering units

Example 3

Some TDAs use data described not in units of measurement (cm, degrees, etc.), but in either ranges of values or narrative terms. Figure 62 illustrates a legend editor for these types of data.

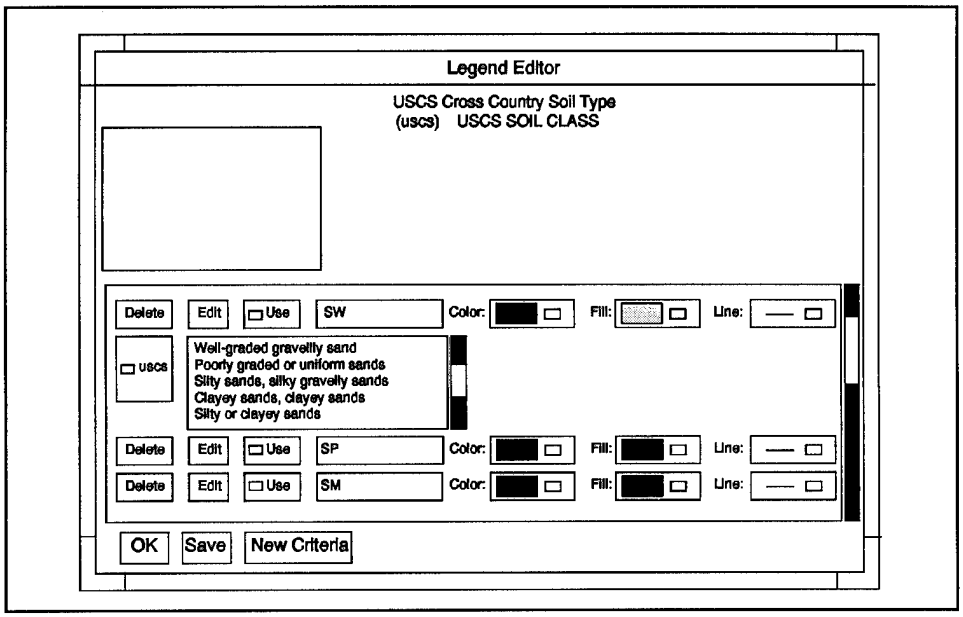

Figure 62. Legend editing form for altering soil class categories

A legend of this type must be edited by specifying the category or categories and the attributes associated with each. This action is illustrated in the previous figure for the category USCS (Unified Soil Classification System).

8 CAMMS-D Data Manager (DatM)

Overview of CAMMS-D DatM

The CAMMS-D Data Manager (DatM) provides the user the capabilities of importing Defense Mapping Agency's (DMA's) Interim Terrain Data (ITD), ARC Digitized Raster Graphics (ADRG), and Digital Topographic Elevation Data (DTED) for use by CAMMS-D. The DatM also allows the user to remove unneeded data from the CAMMS-D system, to copy data to a tape, to copy data from a tape, and to view data available on the CAMMS-D system. A detailed description of operations available within the CAMMS-D DatM is provided in the following paragraphs.

Figure 63 illustrates the CAMMS-D DatM main window.

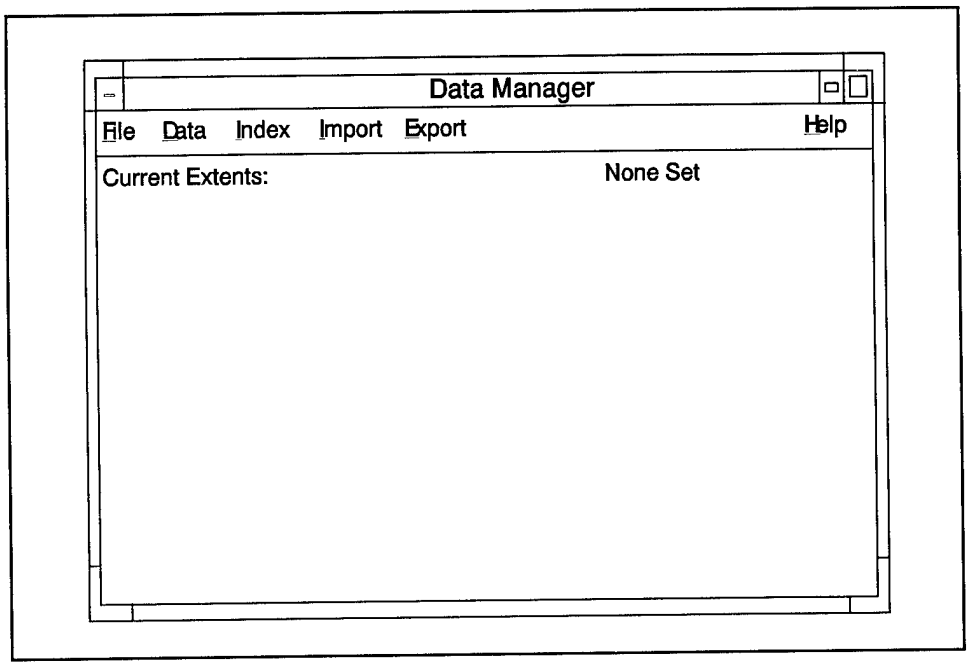

Figure 63. CAMMS-D Data Manager main window

Items in the DatM main menu (File, Data Index, Import, and Export) are discussed briefly under the next four headings. Following that, detailed descriptions under headings "Importing Terrain Data" and "Exporting Terrain Data" show how the CAMMS-D DatM can be used for data management.

File

Selection of this option provides the user capabilities described in the following list.

a. *Quit* - Ends execution of the DatM.

b. *Disk Space* - Shows the user the amount of space available on the hard disk drive for GIS data and CAMMS-D products (referred to as "Work Space Data"). The total space on the disk is denoted as "Total", while the space available for use is referred to as "Free". Figure 64 is a sample window produced by selecting the "Disk Space" option.

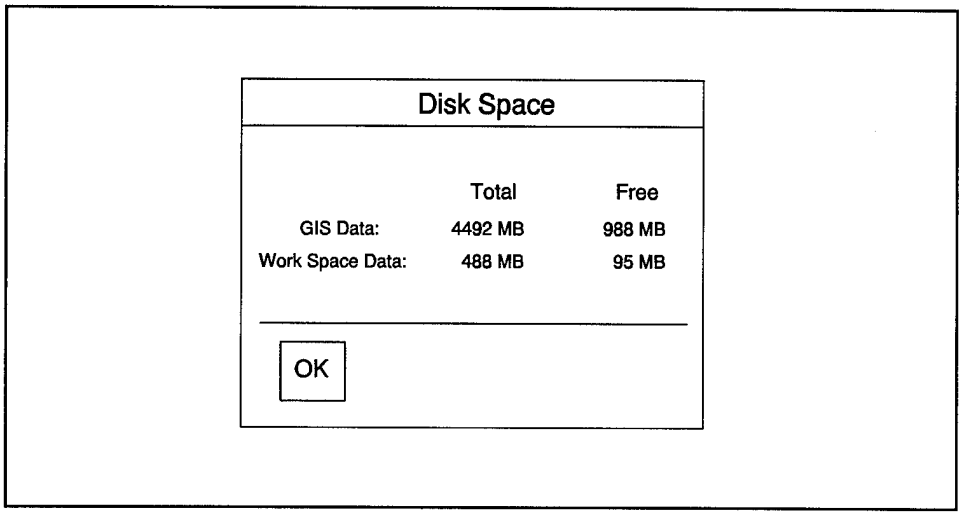

Figure 64. Sample window indicating disk space usage

c. *Browse* - Allows the user to "browse" through the UNIX file system. Selection of the "Browse" option produces the following form shown in Figure 65.

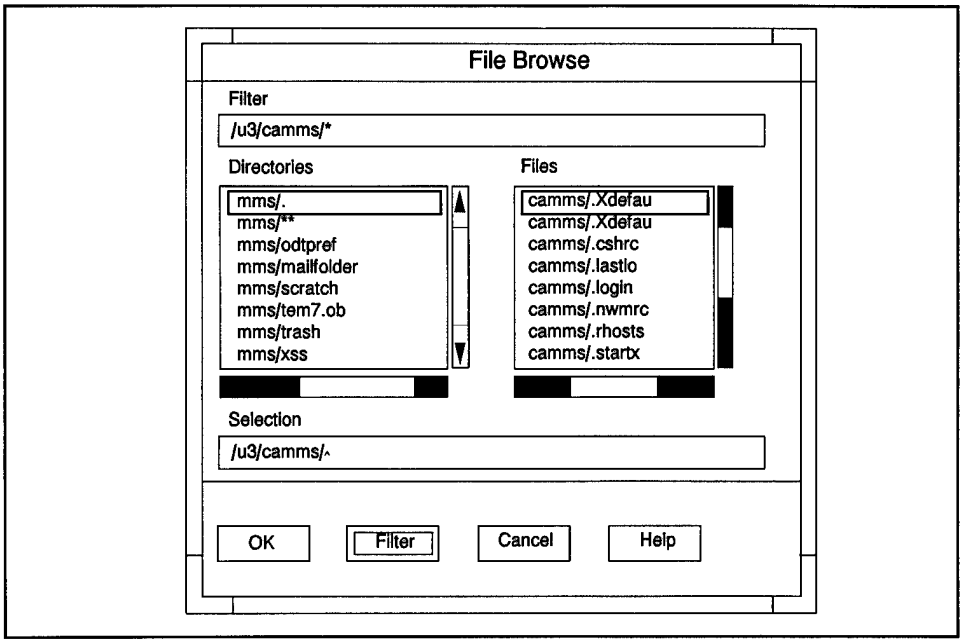

Figure 65. "File Browse" form

The above form allows the user to specify the filter by which to search. The filter is a character string specifying a directory path and, as needed, files within that path. The following are examples of filters.

(1) /usr/one/*

(2) /usr/one/*.dat

Once a filter is specified and "Filter" is pressed, the directories associated with the filter are displayed under the "Directories" column. The highlighted directory in the list can be used as the filter by pressing "Filter". Under the heading "Files" is a listing of the files as specified by the filter. The "Selection" field has no function in this form. "OK" or "Cancel" may be pressed to exit this form.

d. *Path* - Allows the user to set the UNIX path names of the input/output devices. Selection of this option produces the following window shown in Figure 66.

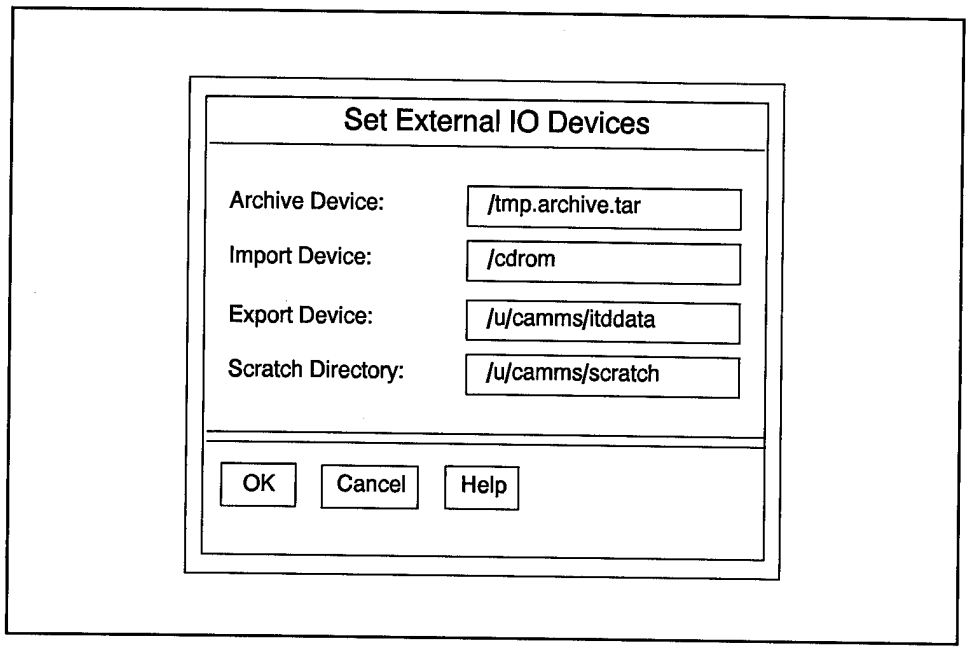

Figure 66. "Paths" form window

The four paths within this form represent input/output devices necessary for performing tasks within CAMMS-D, such as importing GIS data, exporting GIS data, etc. A description of each of the four paths is provided below.

(1) Archive Device - Indicates the file or external storage device (tape device, floppy disk device, etc.) to which all archived data are written.

(2) Import Device - Indicates the device (CD ROM drive, tape drive, floppy disk drive, etc.) from which data will be imported.

(3) Export Device - Indicates the device (hard disk drive and directory, tape drive, floppy disk drive, directory, etc.) to which data will be exported.

(4) Scratch Directory - Indicates the directory on the hard disk drive which will be used for "scratch" work by the system.

e. Update - Provides a CAMMS-D GIS data update capability. Selection of this option produces the following window shown in Figure 67.

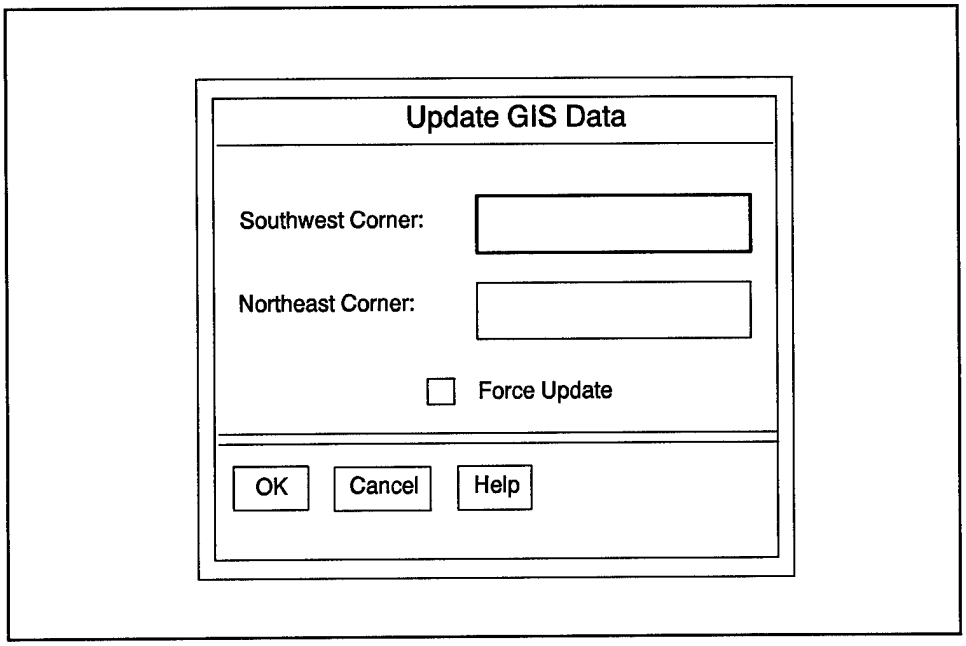

Figure 67. "Update GIS Data" form

The update process converts newly imported GIS data (source data) into the CAMMS-D baseline data format. These source data must be specified by the extents representing the data coverage. During the update process, if the source data have not changed since the most recent update, the conversion procedure will not be performed. If the "Force Update" switch is turned "on", the conversion process will be performed, regardless of whether the baseline data are recent.

f. Remove - Allows the user to remove unwanted GIS data from the system. Selection of this option produces the following form in Figure 68.

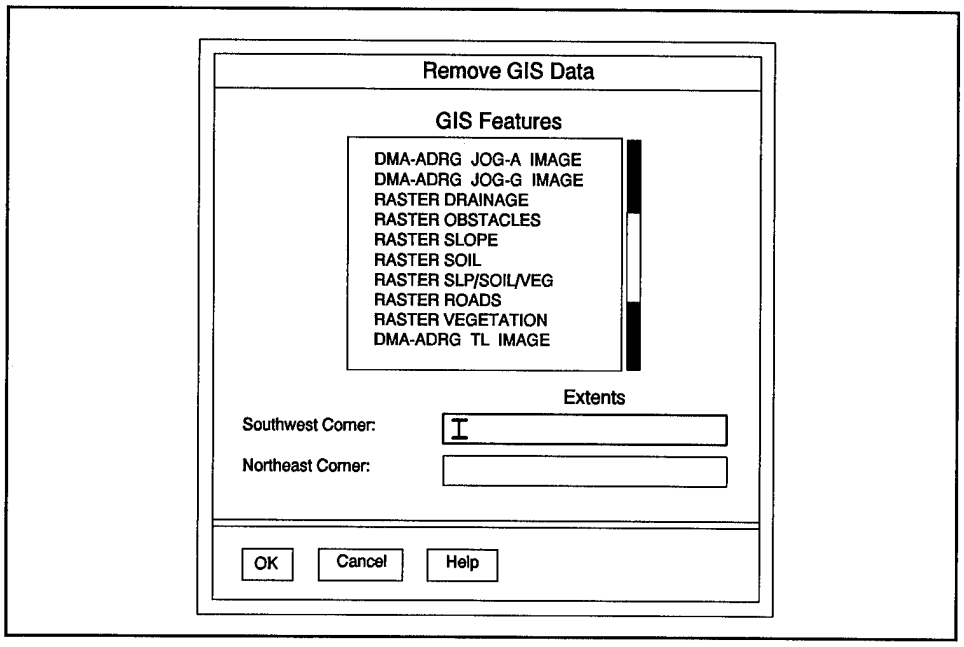

Figure 68. "Remove GIS Data" form

The form illustrated above allows the user to specify the data to remove by highlighting the feature representing data and by supplying the data extents which specify the coverage of the data to be removed.

g. Register archive - Allows the user to inform the system that an archive media (CD, tape, etc.) or file has been loaded into the location (directory) or device specified through the "Paths" option.

Data index

Selection of this option allows the user to view the data presently installed ("on-line") on the system. Selection of the "ON-LINE" option produces the following form in Figure 69.

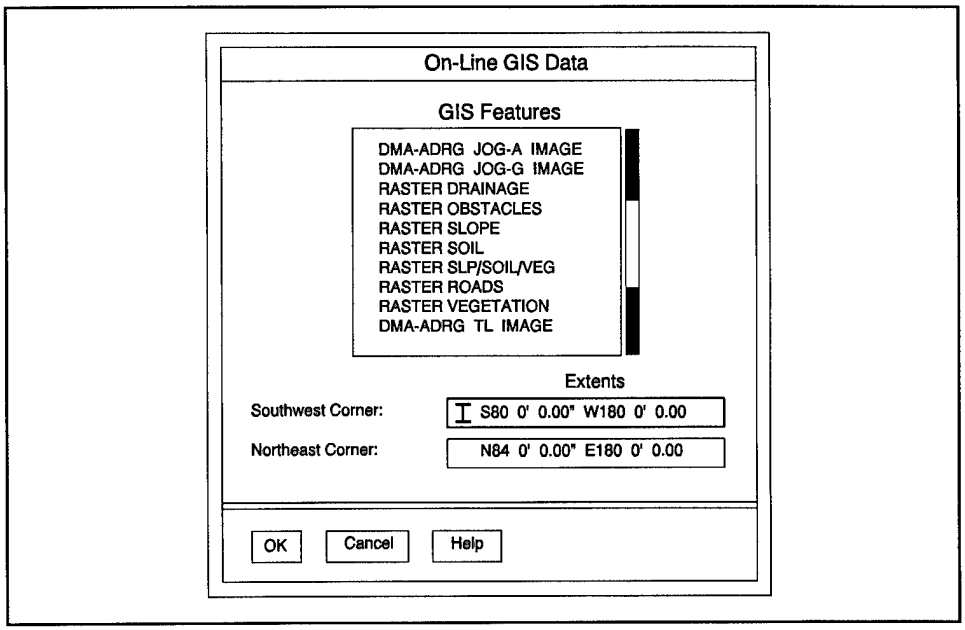

Figure 69. "On-Line GIS Data" form

On this form, the user can highlight the feature of interest and specify the extents of the area in which data coverage is needed. Once these items have been specified and "OK" is pressed, the system will inspect the data for coverage within the area specified. During this search, the system will display a clock which monitors the time lapse during the search. When the search is complete, a window will appear showing the coverage data available within the specified area. If no data coverage is found within the specified area, a message will appear indicating so.

Import

Selection of this option allows the user to specify and import data of a user-selected type (DTED, ITD, ADRG, or archived data). These data may be imported from the original ITD source or from data archived by the CAMMS-D system. A detailed description of the import operation is provided subsequently under "Importing Terrain Data".

Export

Selection of this option allows the user to export data which are installed on the system. Exporting data may be necessary if the data are no longer needed, or if disk space occupied by the data is needed. The exported data will be archived for storage. A detailed description of the export operation is provided subsequently under "Exporting Terrain Data."

Importing Terrain Data

Overview

The CAMMS-D DatM provides capabilities for importing DMA terrain data products (DTED Level I, ITD, and ADRG) into the CAMMS-D system for use within CAMMS-D. Additionally, the CAMMS-D DatM provides the capability of importing (restoring) terrain data from an archive created through the CAMMS-D DatM export capabilities. (A detailed description of these export capabilities is provided subsequently under "Exporting Terrain Data".)

Pressing "Import" on the DatM main menu produces the following pull-down menu shown in Figure 70.

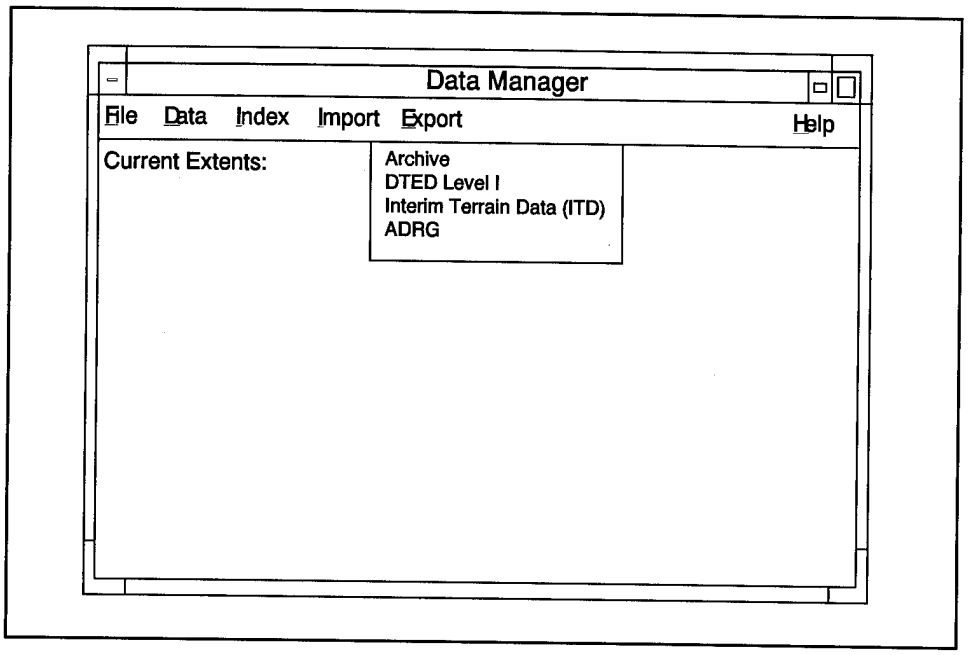

Figure 70. DatM "Import" menu

The items on this menu represent the CAMMS-D DatM capabilities for importing archived terrain data, DTED Level I, ITD, and ADRG. Paragraphs under subsequent headings provide details on utilizing the CAMMS-D DatM import capabilities.

Importing archived terrain data

The CAMMS-D DatM provides capabilities for importing (restoring) terrain data which have been archived by the DatM. To restore the archived terrain data, the user should select the "Archive" option on the Import menu; this action produces the following form in Figure 71.

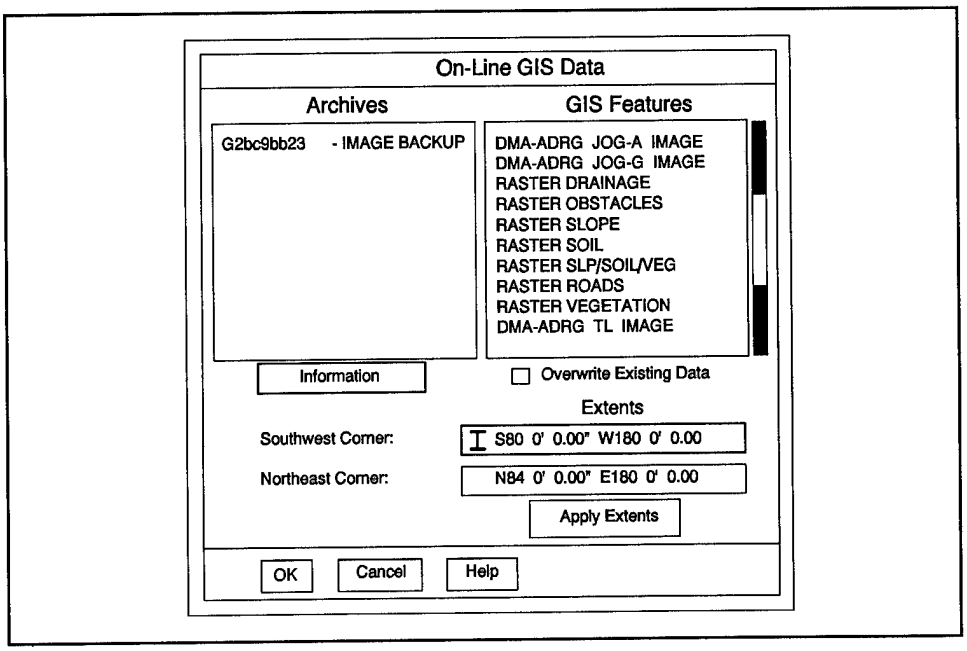

Figure 71. "Archive" form

The form illustrated above provides a list of the available archives. Information about any one archive can be obtained by highlighting an archive in the list and pressing "Information". The information associated with each archive includes the archive name, a brief description of the archive, the date and time when the archive was created, the coverage of the data contained within the archive, the features associated with the data, and the data size, both compressed and noncompressed.

Only archives containing a specified data coverage can be displayed in the list; this is done by entering the extents in the lower portion of the form and pressing "Apply Extents".

The desired GIS feature(s) to be imported from the archive should be highlighted in the "GIS Features" list located in the upper right part of the form. If the user wants the archived data to overwrite any existing data providing the same coverage, he/she should activate the "Overwrite Existing Data" option.

When all fields are properly filled, press "OK".

Importing DTED Level I

The CAMMS-D DatM provides capabilities for importing DTED Level I terrain data into the CAMMS-D system. To accomplish this, the user should first select the "DTED Level I" option from the Import menu; this action produces the following form shown in Figure 72.

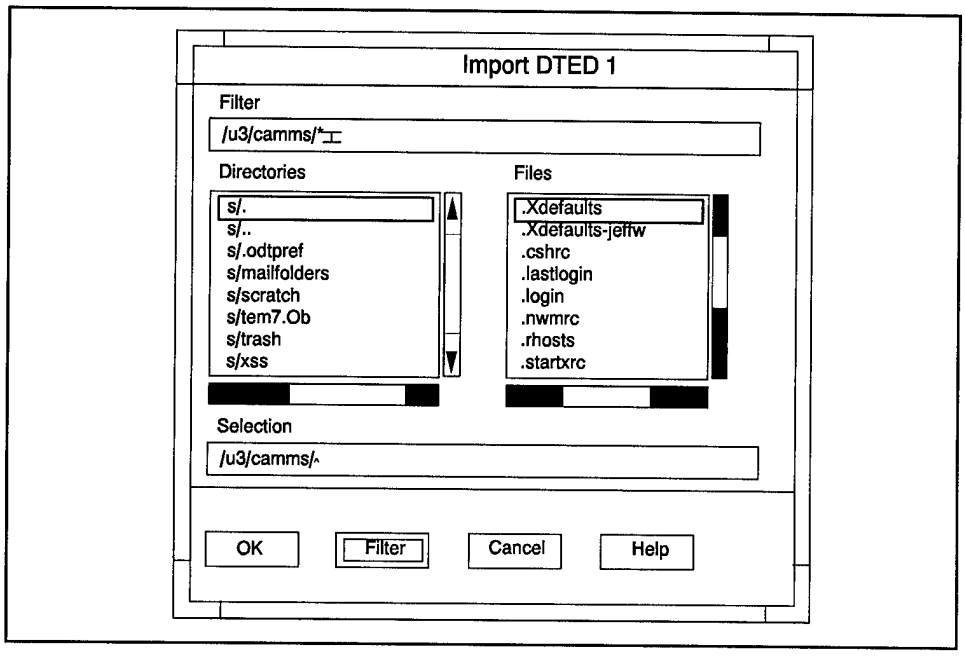

Figure 72. "Import DTED I" form

DTED Level I is distributed by DMA on CD ROMs. Each file on a CD ROM represents one 1 degree x 1 degree cell. The following information illustrates the method used for storing a cell of DTED Level I on the CD ROM. From the above form, the DTED coverage for the cell N27E034 would be stored in the file "n27.dt1;1" under the directory "dted/e034" denoted by the following path.

dted/e034/n27.dt1;1

DTED coverage for the cell N26E033 would be stored in the file denoted by the following path.

dted/e033/n26.dt1;1

The form illustrated above must be used to specify the DTED cell for importing. This is accomplished by specifying the filter used to locate the desired DTED file. Once the filter is specified, press "Filter". The directories associated with that filter will appear in the "Directories" list. Highlighting one of the directories will prompt the system to display the files (in the "Files" list) within that directory. Highlight one of the files in the list to complete the file selection. The completed selection will appear in the form field labeled "Selection". Pressing "OK" then begins the importing process.

Importing ITD

The CAMMS-D DatM provides capabilities for importing ITD into the CAMMS-D system for use by CAMMS-D. To accomplish this, first select "Interim Terrain Data (ITD)" from the Import menu. This action produces the following form in Figure 73.

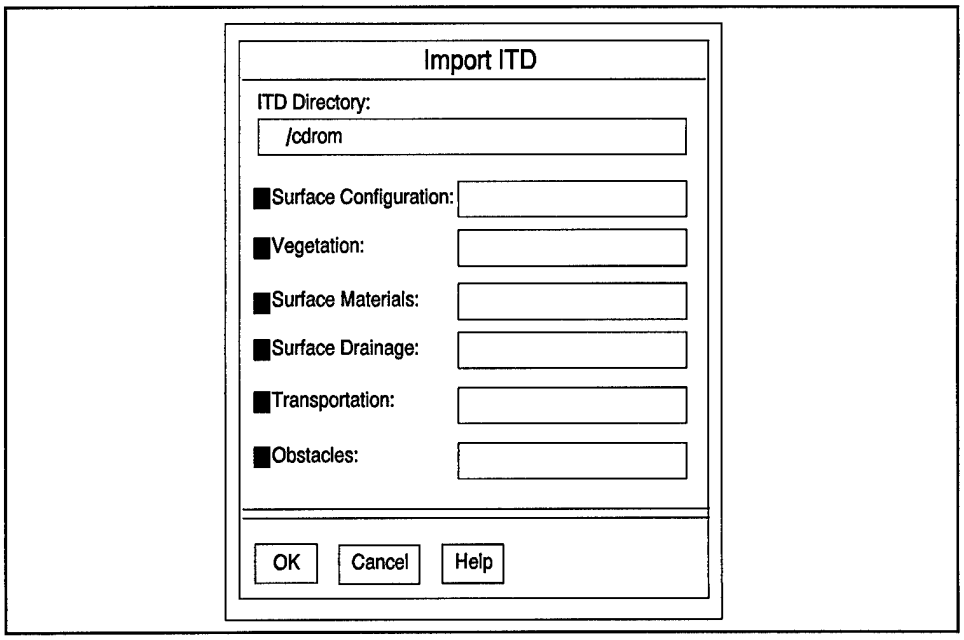

Figure 73. "Import ITD" form

Input the source directory of the ITD in the field labeled "ITD Directory:" located near the top of the form. The remaining fields on the form ("Surface Configuration:", "Vegetation:", "Surface Materials:", "Surface Drainage:", "Transportation:", and "Obstacles:") represent the features available within ITD. Selecting a given feature to be imported is done by "turning-on" the small switch located to the left of that item. To import an ITD feature, a file

name must be specified. The file represented by this name must contain the ITD data for that feature. Figure 74 demonstrates the settings necessary to import ITD vegetation data (contained in file "veg.itd") located in the directory "/usr/data2".

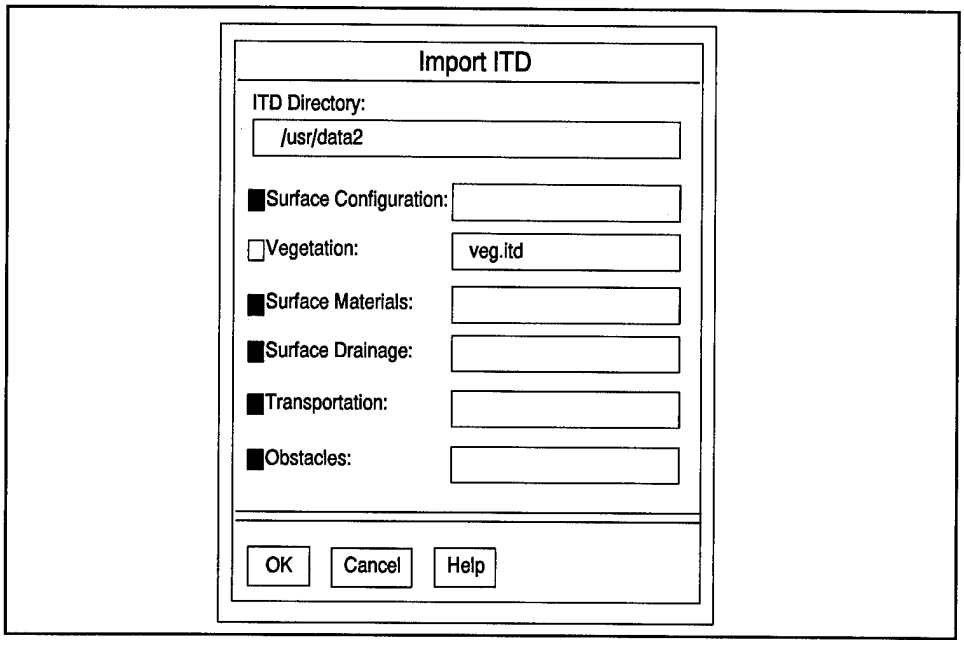

Figure 74. "Import ITD" form setting for reporting ITD vegetation

When the settings are complete, press "OK" to begin the ITD import process.

Importing ADRG

The CAMMS-D DatM provides capabilities for importing ADRG into the CAMMS-D system for use by CAMMS-D as image maps (TL, JOG-G, JOG-A, TPC, and ONC). To accomplish this, first select the "ADRG" option from the Import menu. This action will produce the following form shown in Figure 75.

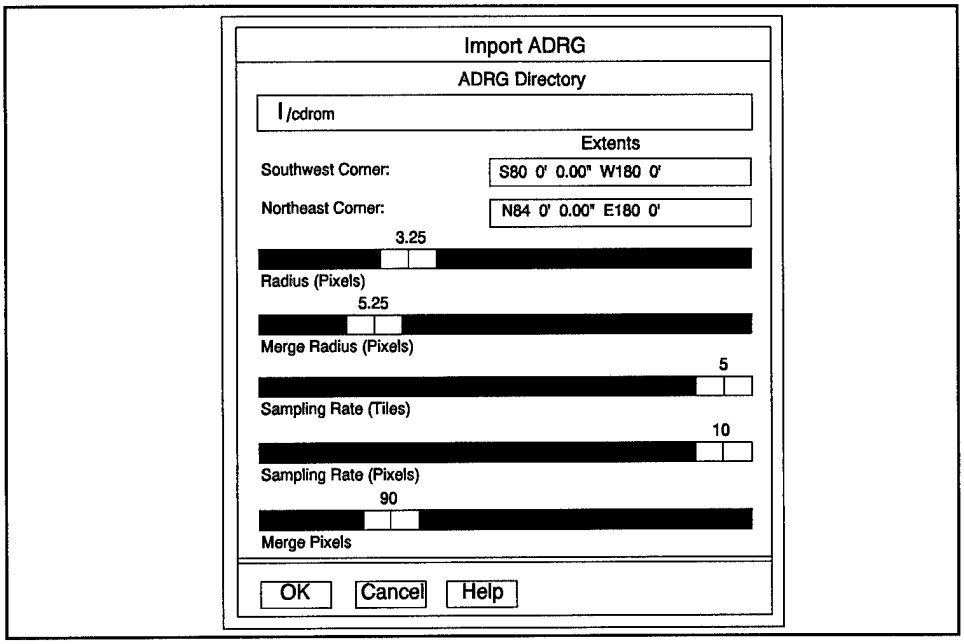

Figure 75. "Import ADRG" form

The directory in which the ADRG data reside should be entered in the field labeled "ADRG Directory:" near the top of the form. The extents of the area to be imported should be entered in the fields labeled "Extents". The remaining five inputs on this form consist of "slide-bars". The names of these five inputs and the purpose of each are provided below.

a. *Radius.* The minimum spectral distance used to determine when a cluster (or group of pixels) should be formed.

(1) Minimum Value: 0.5

(2) Maximum Value: 10.0

(3) Default Value: 3.25

b. *Merge Radius.* The distance used when merging clusters.

(1) Minimum Value: 0.5

(2) Maximum Value: 20.00

(3) Default Value: 5.25

c. *Sampling Rate (tiles).* A value controlling the sampling rate of tiles. Increasing this value decreases the total import time; however, the quality of color conversion may also be decreased. For fastest results, set to 5.

(1) Minimum Value: 1

(2) Maximum Value: 5

(3) Default Value: 1

d. *Sampling Rate (pixels).* A value controlling the sampling rate of pixels. Increasing this value decreases the total import time; however, the quality of the color conversion may also be decreased. For fastest results set to 10.

(1) Minimum Value: 1

(2) Maximum Value: 10

(3) Default Value: 1

e. Merge Pixels - the number of pixels to be analyzed between each merging of clusters (if merging is necessary).

(1) Minimum Value: 50

(2) Maximum Value: 200

(3) Default Value: 128

Exporting Terrain Data

The CAMMS-D DatM provides the capability of exporting terrain data (which have previously been imported into CAMMS-D) to free storage space or to transfer to another CAMMS-D system. To export terrain data, select "Export" from the CAMMS-D DatM main menu, followed by "Archive". This action will produce the following form in Figure 76.

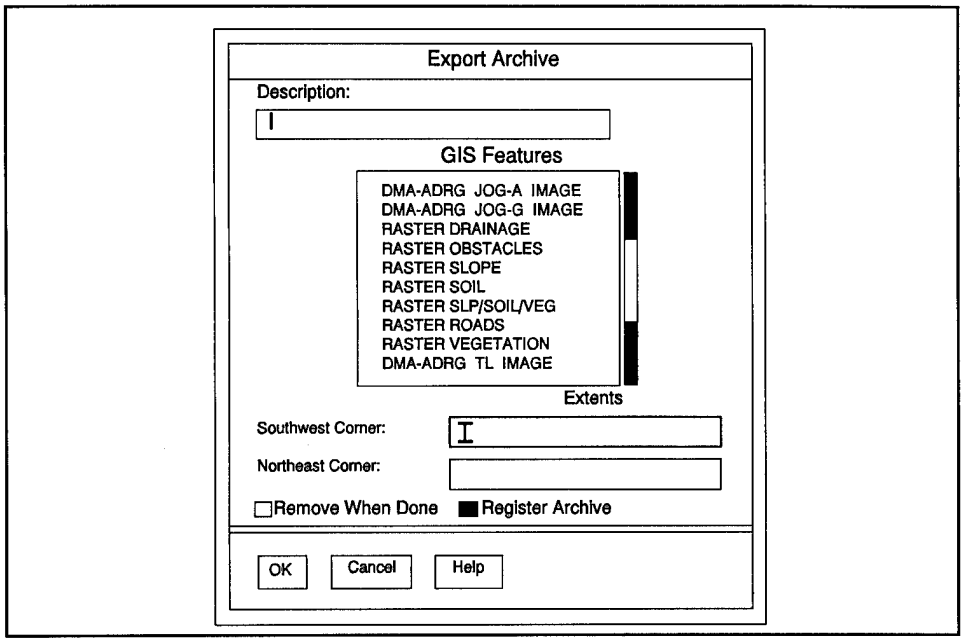

Figure 76. "Export Archive" form

A description of the archive file can be entered in the field labeled "Description:" near the top of the form. This description is simply a character string which allows the user to identify this particular archive.

The GIS features to be archived must be highlighted in the GIS feature list on the form. Additionally, the extents representing the data coverage should be provided in the fields labeled "Extents".

Two switches ("Remove When Done" and "Register Archive") located near the bottom of the form allow the user to remove the data archive, and to register the archive within the CAMMS-D system, respectively. When data are archived for the purpose of creating storage space on the system, activating "Remove When Done" removes the terrain data from the system. When an archive is being created for this purpose or to copy data to another system, there is no need to register the archive; therefore, the "Register Archive" switch should be deactivated.

9 Baseline Terrain Factors

Introduction

Users of the CAMMS-D software may wish to visualize the terrain factors which were used by the risk-based mobility applications in performing a mobility analysis; therefore, developers of the CAMMS-D software provided capabilities to graphically display the Baseline Terrain Factors.

"Baseline Terrain Factors" is the generic term used in this user's guide to correspond to the group of individual TDAs listed below. This is done herein to avoid repetition in the descriptions of these TDAs because (a) the same few steps are involved to utilize each TDA and (b) the interpretation of each TDA is straightforward. Note: The generic term "Baseline Terrain Factor TDAs" appears only in this guide and not in the CAMMS-D software system where each TDA below is treated separately.

a. BTF Dam/Lock Locations TDA defines the locations of dams and locks.

b. BTF Drainage Network TDA defines the locations of streams, rivers, ford/raft sites, etc.

c. BTF Driver Visibility, Spring TDA defines the distance visible to the vehicle driver during Spring.

d. BTF Driver Visibility, Summer TDA defines the distance visible to the vehicle driver during Summer.

e. BTF Driver Visibility, Fall TDA defines the distance visible to the vehicle driver during Fall.

f. BTF Driver Visibility, Winter TDA defines the distance visible to the vehicle driver during Winter.

g. BTF Elevation (DTED Level I) TDA defines the locations of areas having elevations within specified ranges of values (based on Digital Terrain Elevation Data, Level I).

h. BTF Land Classification TDA defines the various uses of the land.

i. BTF Obstacle Locations and Types TDA defines locations and types of natural and man-made linear obstacles.

j. BTF Railroad Network TDA defines the locations of railroad track and associated railroad infrastructure.

k. BTF Road Type TDA defines roads according to four types: super-highways, primary roads, secondary roads, trails.

l. BTF Slope Category TDA defines the categories (ranges) of slope measurements.

m. BTF Soil Type TDA identifies cross-country soil types (aggregated from the Unified Soil Classification System).

n. BTF Surface Roughness TDA defines microroughness of the ground and roads in measurements related to vehicle mobility (root-mean-square elevation).

o. BTF Transportation Network TDA defines the locations of the various parts of a transportation network (highways, roads, bridges, tunnels, railroads, airfields, etc.).

p. BTF Vegetation Spacing TDA defines the relation between vegetation (tree) diameter and spacing.

Graphical examples of some of these TDAs are included at the end of this Chapter in Figures 77 - 82..

Utilizing the BTF TDA

Steps to utilize the TDA are as follows:

a. From the Display Manager main menu, select "Display" followed by "Products".

b. From the "Product Group" list on the Product Manager form select "Terrain Factors".

c. A list of products will appear on the Product Manager form. Select (highlight) one of the BTF TDAs in the list and press "Select".

d. Press "PLOT". The selected BTF TDA will be plotted.

e. To remove a given BTF overlay, return to the Product Manager form and remove the overlay from the active products list. This is accomplished by highlighting the product in the "Active Products" list and pressing "Remove".

Example Scenario and TDA Walk-Through

Your unit's commander needs to evaluate the transportation network for a specified mapped area, with trails not considered, and with the network keyed to locations of major terrain/manmade features of the area. Your task: Produce such an overlay.

Steps to produce the required overlay of a BTF Transportation Network TDA imposed over a background image map are as follows:

a. From the Display Manager main menu, select "Display".

b. From the Display menu, select "Map Control".

c. A Map Control window will appear. Ensure that the desired background image map is activated.

d. Press "OK".

e. From the Display Manager main menu, select "Display" followed by "Products".

f. From the "Product Group" list, select "Terrain Factors".

g. Highlight "BTF Transportation Network" and press "Select".

h. Press "PLOT".

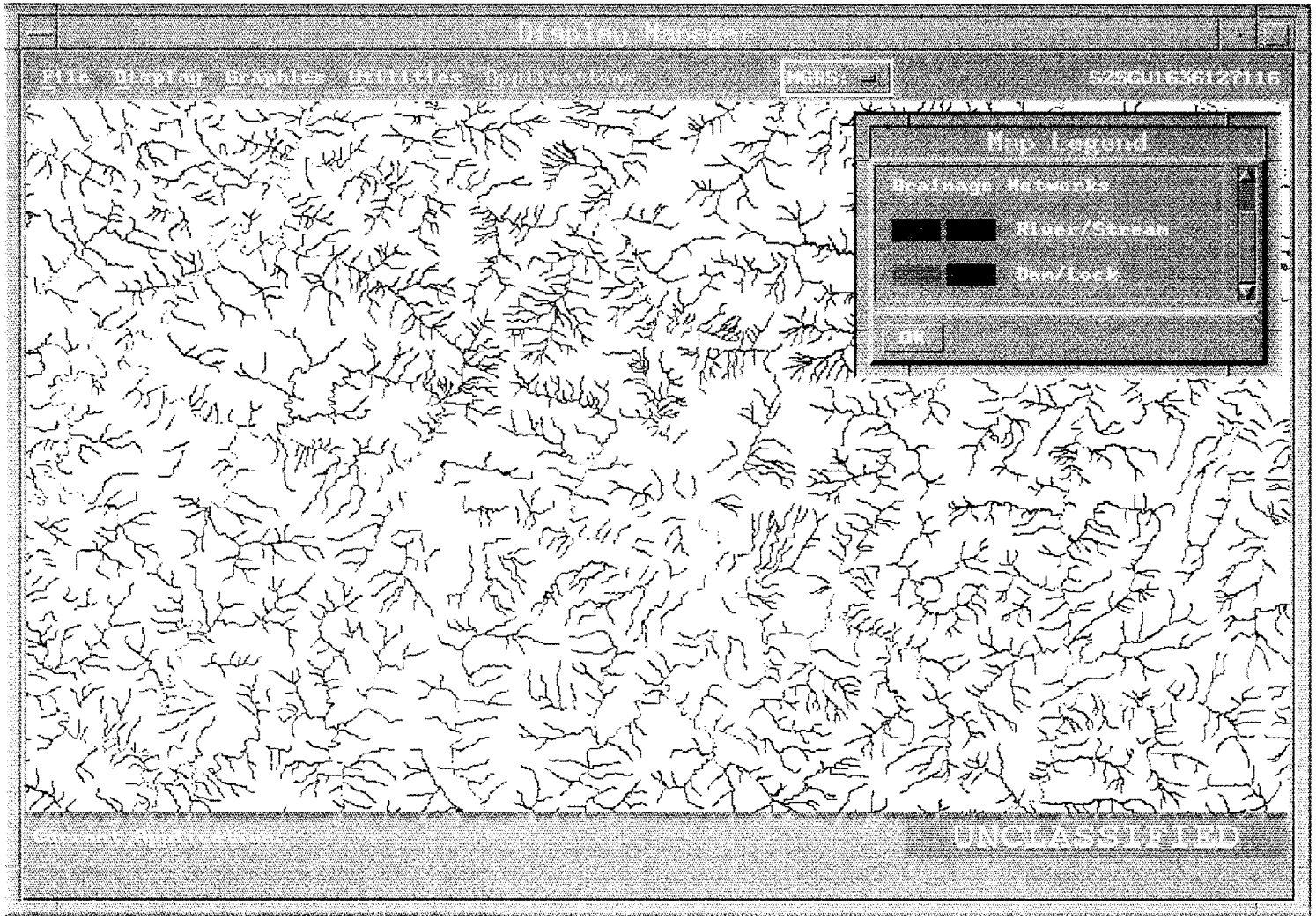

Figure 77. Sample BTF drainage network TDA

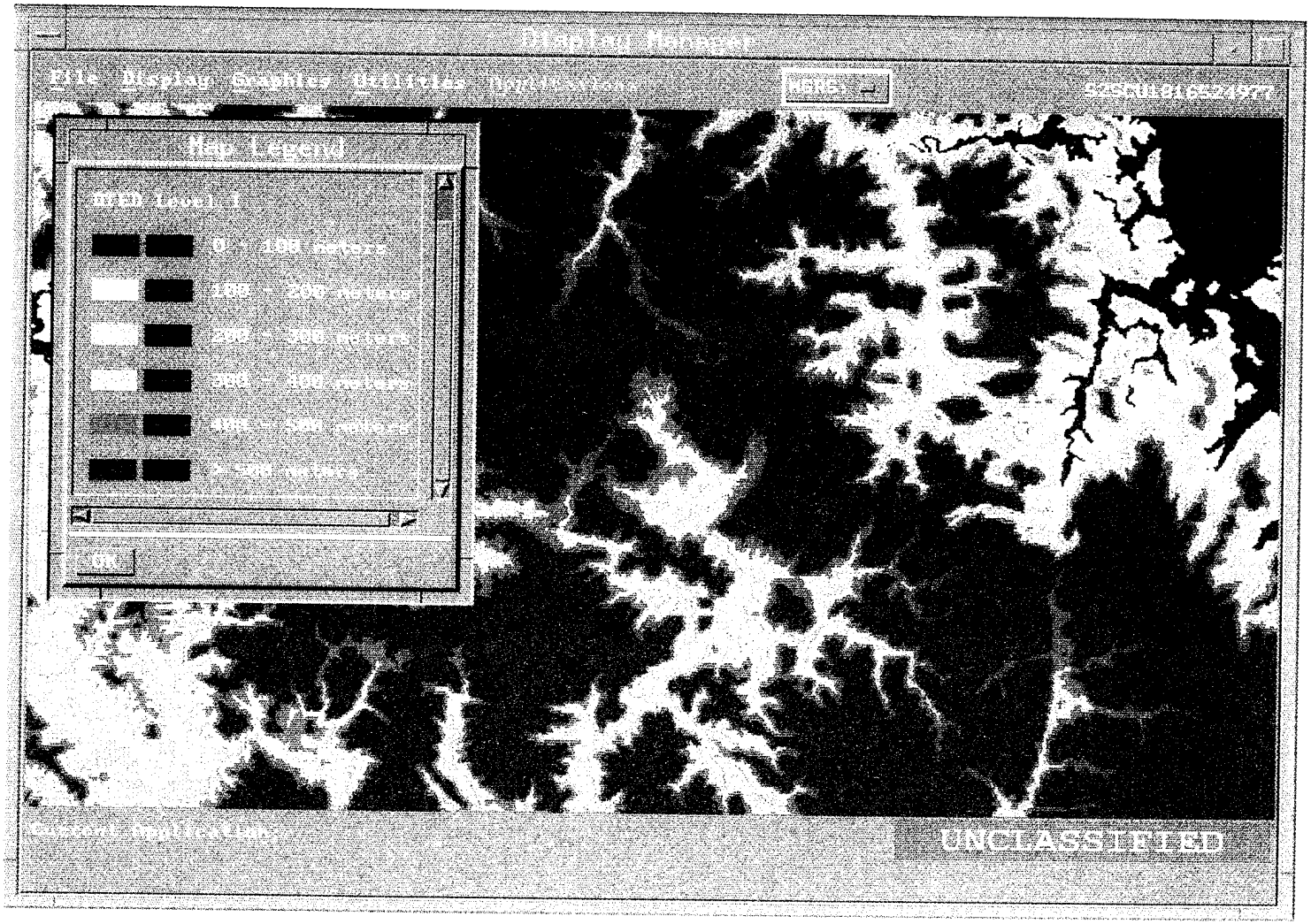

Figure 78. Sample BTF elevation (DTED Level I) TDA

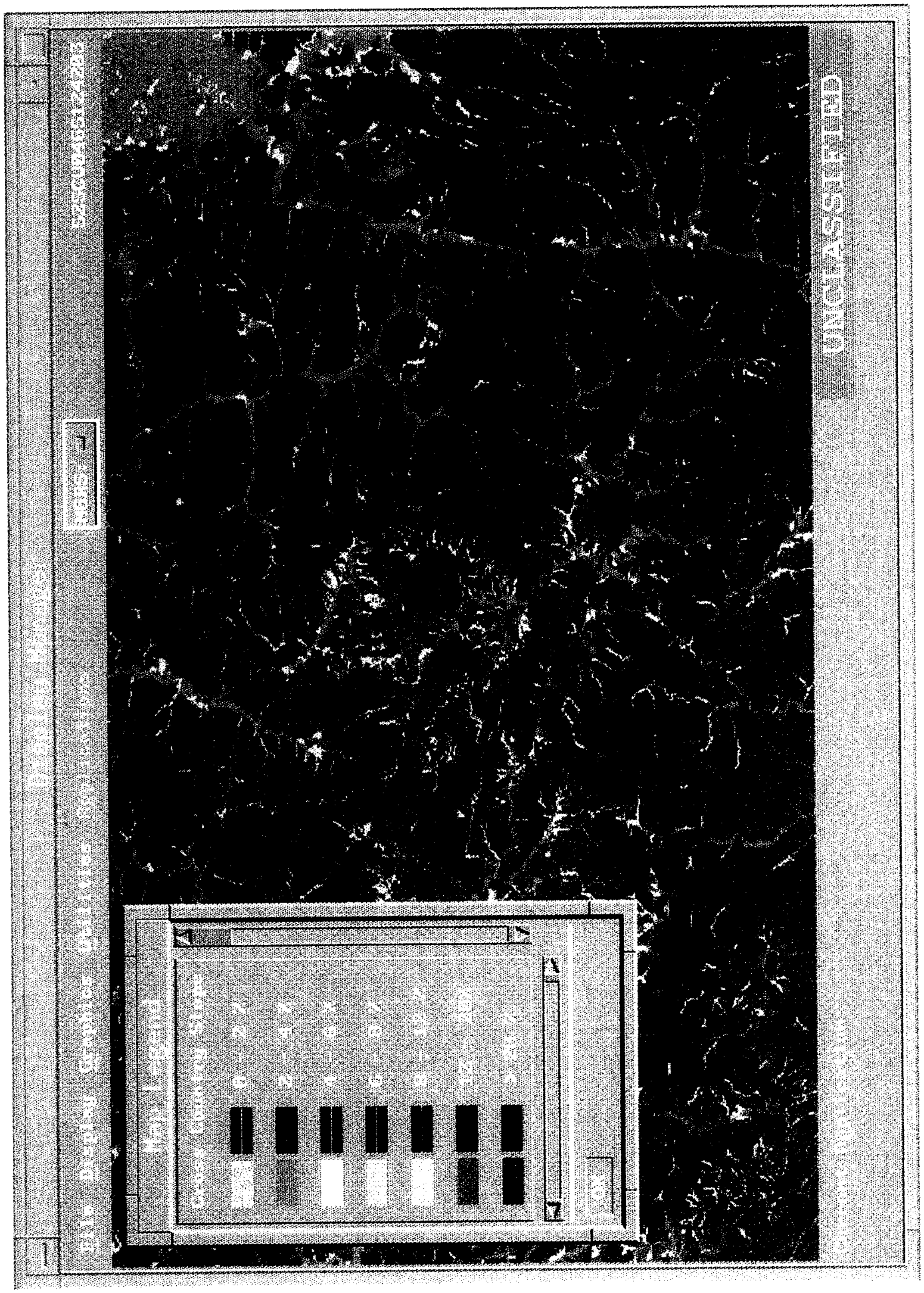

Figure 79. Sample BTF slope category TDA

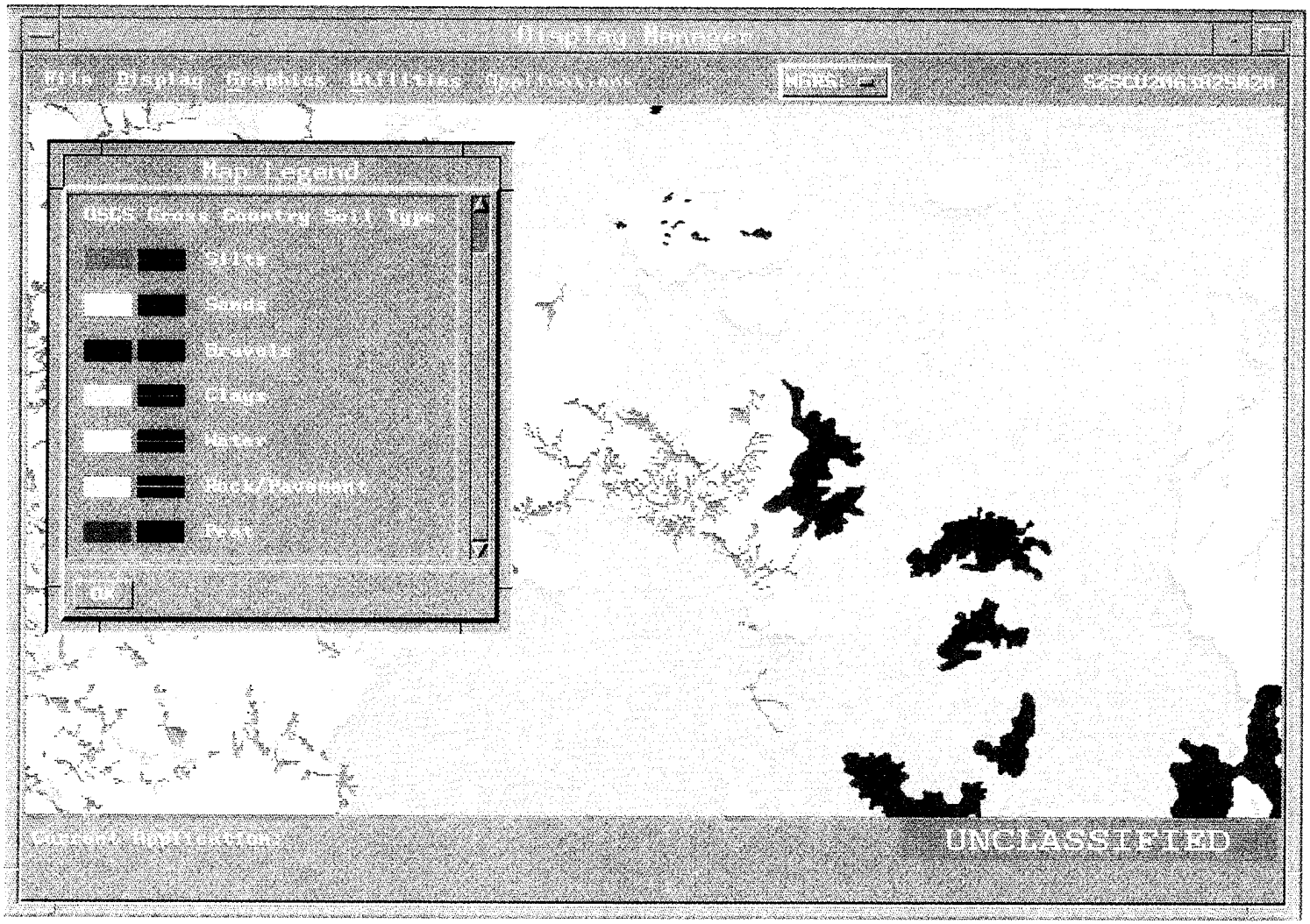

Figure 80. Sample BTF soil type TDA

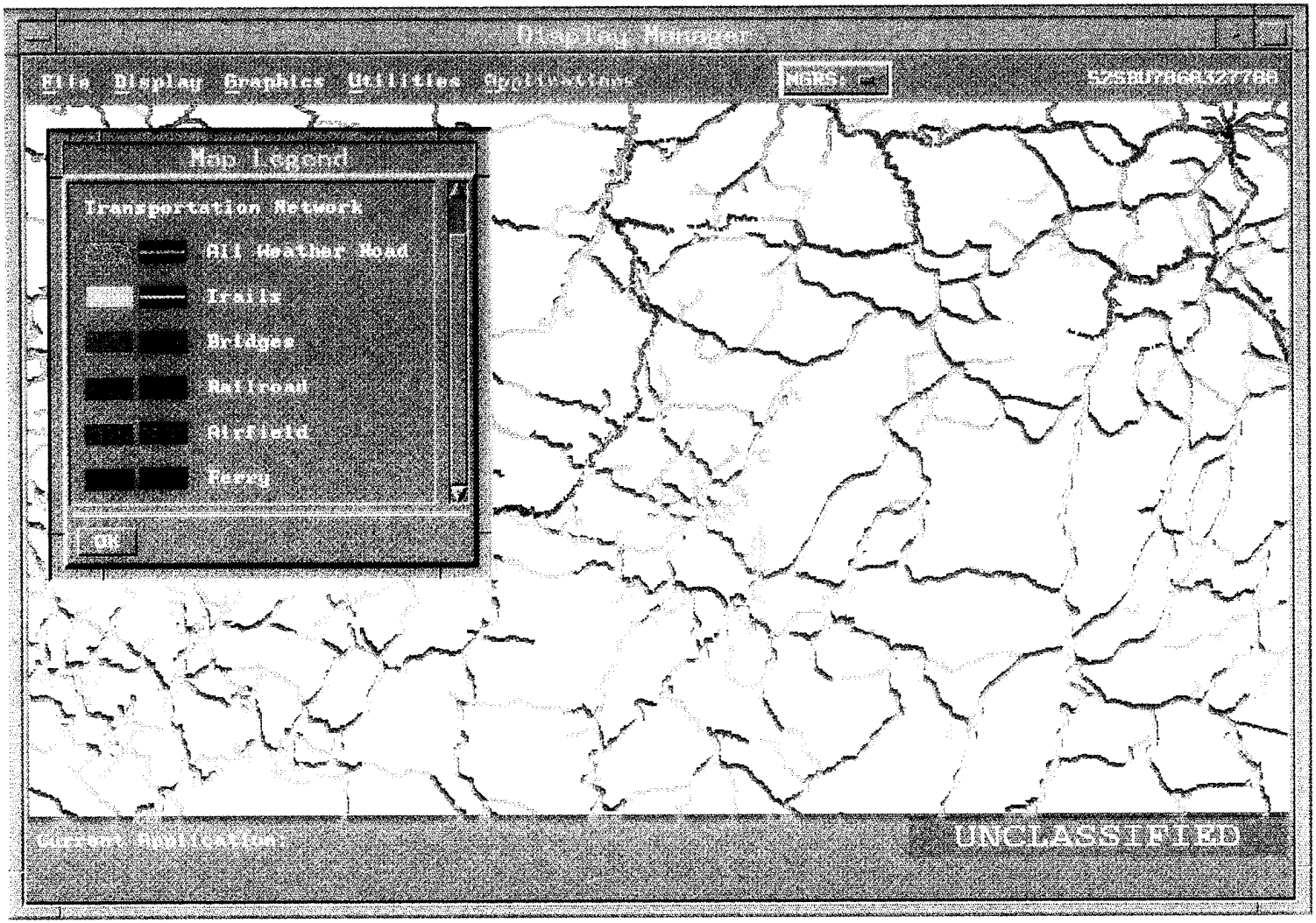

Figure 81. Sample BTF transportation network TDA

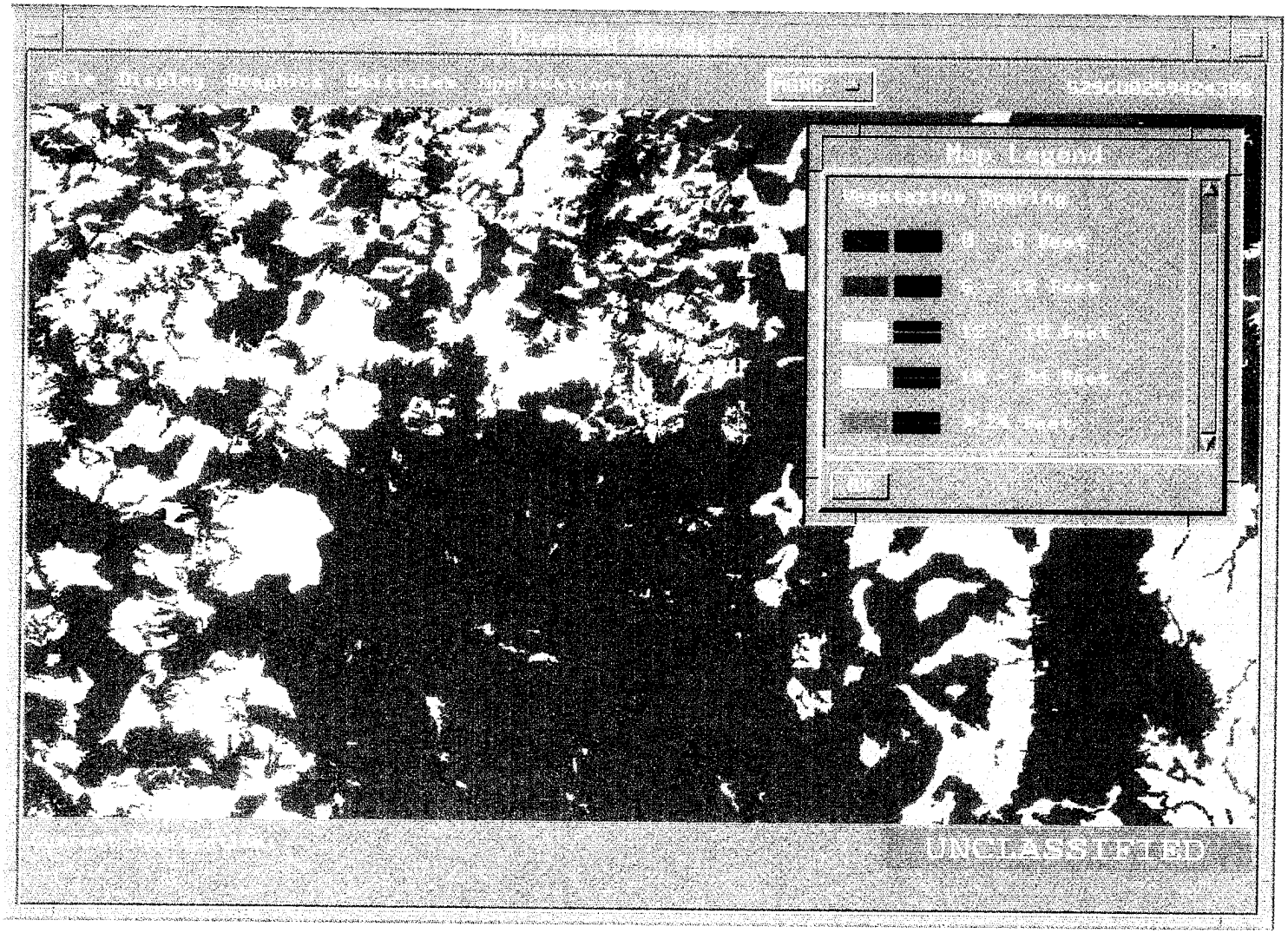

Figure 82. Sample BTF vegetation spacing TDA

10 Soil Strength Analysis

Introduction

The Soil Strength Analysis TDA uses predictions made by the Soil Moisture/Strength Prediction (SMSP) model to provide the user a graphical representation (overlay) of estimated soil strength based on user inputs to the SMSP--soil type, amount and type of precipitation, and area and time of interest among other things. A detailed description of the SMSP Model can be found in Kennedy et al. (1988).

The user is required to provide the following information.

a. Selection of historical weather data or actual weather gauge reports.

b. Date for soil strength analysis

c. If historical weather data are used, a general description of intensity of rainfall (dry, average, wet).

A graphical representation (overlay) of predicted soil strength results from a Soil Strength Analysis performed within the TDA. The user can display the soil strength overlay produced by the TDA and can edit the legend associated with the displayed overlay.

Software for the Soil Strength Analysis TDA performs operations described by the SMSP model. The SMSP increases or decreases moisture content of the soil as a function of rainfall amount, soil type (Unified Soil Classification System), and drainage characteristics of the terrain (wetness index). To maintain current soil moisture/strength data, the SMSP must be executed once every 24 hours. Soil strength is described by the SMSP in terms of cone index (CI) for coarse-grained soils (sands, gravels, etc.), rating cone index (RCI) for fine-grained soils (clays, silts, etc.). CI and RCI values range from near zero (very weak) to 300 and higher (very strong). To provide an indication of CI and RCI values: a highly mobile wheeled vehicle can make one pass in soil of a CI or RCI value of about 50; most conventional wheeled vehicles can make 50 passes in a soil of CI or RCI value of about 70.

Utilizing the Soil Strength Analysis TDA

Creating a new Soil Strength Analysis

To create a new Soil Strength Analysis, perform the following steps.

a. From the Display Manager main menu, select "Display" followed by "Products".

b. From the "Product Group" list on the PM form select "Weather Effects".

c. From the list of products on the Product Manager form, highlight "Soil Moisture Strength Prediction (SMSP)." Press "Create".

d. The following form in Figure 83 will appear.

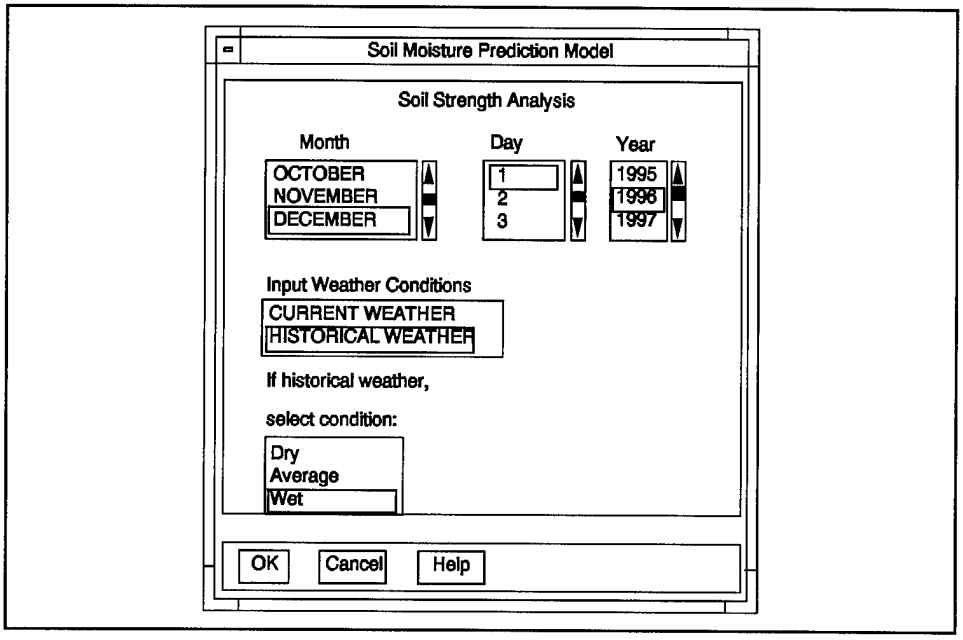

Figure 83. Soil Strength Analysis form

This form allows the user to specify whether to use actual weather data or historical weather data. If actual weather data are to be used, then all but the final item in the form must be completed. If historical weather data are to be used, then the user must complete the final entry. Actual weather data are introduced to the system through the "Weather Effects" product category on the "Product Group" list. The weather report must be updated in that category before performing a Soil Strength Analysis within this TDA.

e. After all of the fields in the form are complete, "OK" should be pressed to perform the Soil Strength Analysis. Pressing "Cancel" will cause the system to ignore the changes on the form and to abort the Soil Strength Analysis.

Editing Soil Strength Analysis Legend

To edit the legend of a previously created Soil Strength Analysis, perform the following steps.

a. From the Display Manager main menu, select "Display" followed by "Products".

b. From the "Product Group" list on the PM form select "Weather Effects".

c. From the list of products on the Product Manager form, select (highlight) "Soil Moisture Strength Prediction (SMSP)". Press "Edit".

d. The following menu (Figure 84) of Soil Strength Analysis types will appear.

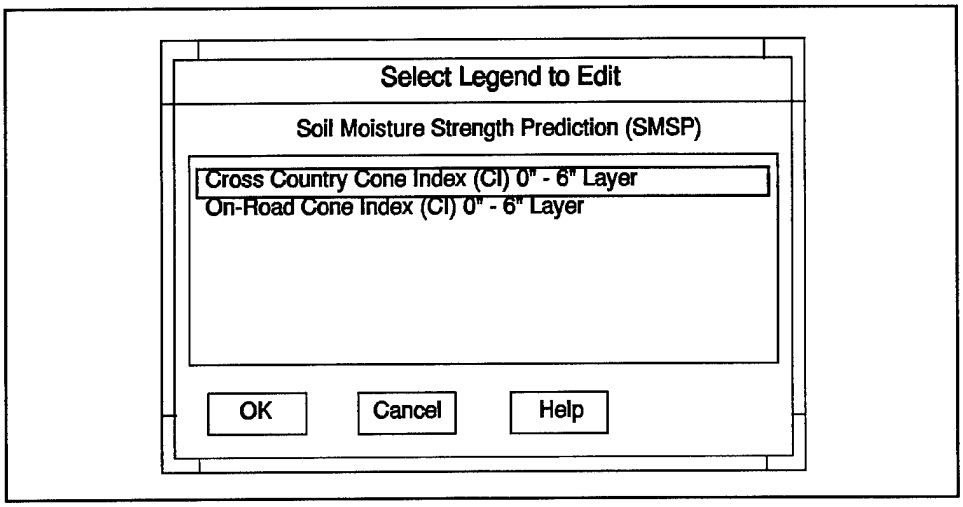

Figure 84. SMSP Legend editing form

Highlight the desired soil strength analysis type.

e. Press "OK" to accept the selection and to continue. Pressing "Cancel" will cause the editing process to be aborted.

f. The system will now allow the legend to be edited. Refer to information under the heading "Editing Legends of TDA Products" of Chapter 7.

Displaying a Soil Strength Analysis Overlay

To display a previously created Soil Strength Analysis overlay, perform the following steps.

a. From the Display Manager main menu, select "Display" followed by "Products".

b. From the "Product Group" list on the PM form select "Weather Effects".

c. From the list of products on the Product Manager form highlight "Soil Moisture Strength Prediction (SMSP)". Press "Select".

d. A list of previously created Soil Strength Analyses will appear. Highlight the desired soil strength analysis.

e. Press "OK" to accept the selection and to continue. Pressing "Cancel" will cause the selection process to be aborted.

f. On the Product Manager form, press "PLOT" to display the results of the Soil Strength Analysis.

Example Scenario and TDA Walk-Through

Your unit's commander needs to evaluate the soil strength characteristics within a specified mapped area. In particular, he has requested a Soil Strength Analysis overlay of the area with legend edited to emphasize ranges of low soil strength. Task: Produce such an overlay.

To produce the required TDA, steps must be performed to create the Soil Strength Analysis, edit the legend, and display the Soil Strength Analysis TDA. A description of these steps follows.

a. Steps to create the Soil Strength Analysis are:

(1) From the Display Manager main menu, select "Display" followed by "Products".

(2) From the "Product Group" list on the PM form select "Weather Effects".

(3) From the list of products on the Product Manager form highlight "Soil Moisture Strength Prediction (SMSP)". Press "Create".

(4) Specify the scenario conditions in terms illustrated in Figure 85.

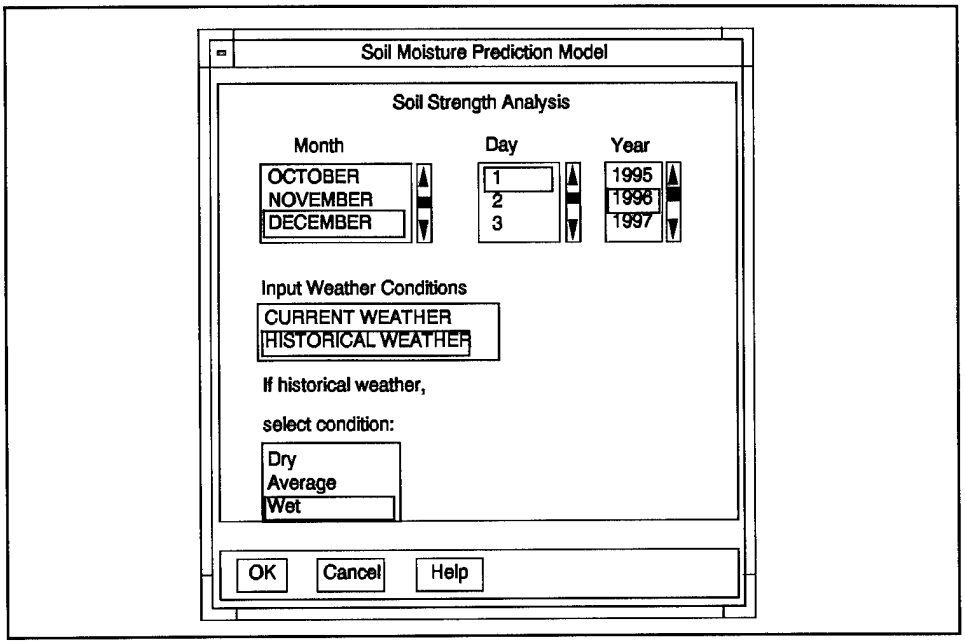

Figure 85. Soil Strength Analysis form for TDA walk-through

Press "OK" to accept the selection and to continue.

(5) The Soil Strength Analysis will be performed.

b. Steps to edit the legend of the Soil Strength Analysis are:

(1) From the Display Manager main menu, select "Display" followed by "Products".

(2) From the "Product Group" category list, select "Weather Effects".

(3) From the list of products on the Product Manager form, highlight "Soil Moisture Strength Prediction (SMSP)". Press "Edit".

(4) Perform the selection as illustrated in Figure 86.

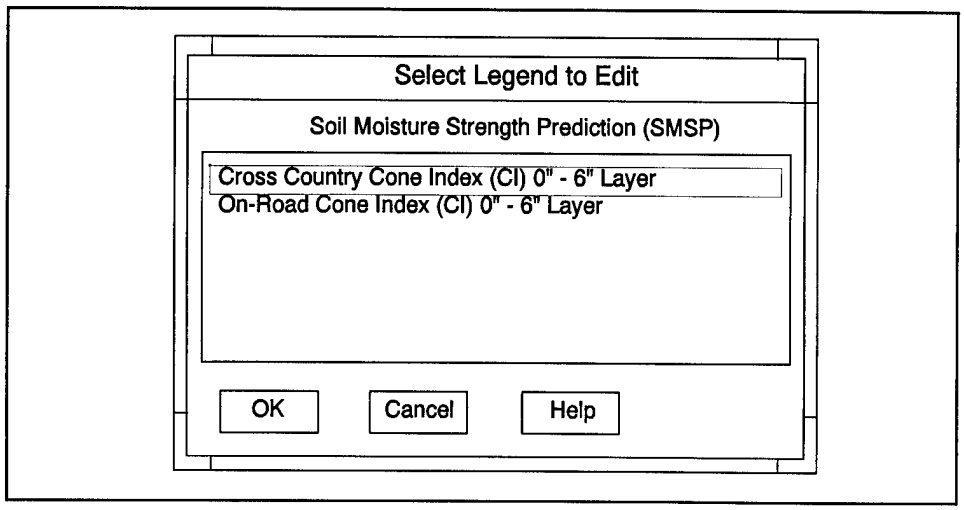

Figure 86. SMSP Legend editing form for TDA walk-through

(5) Press "OK" to accept the selection and to continue.

(6) The system will now allow the legend to be edited. Refer to information under "Editing Legends of TDA Products" of Chapter 7 herein for details of this process. Edit the legend as desired.

c. Steps to display Soil Strength Analysis are:

(1) From the Display Manager main menu, select "Display" followed by "Products".

(2) From the "Product Group" list on the PM form, select "Weather Effects".

(3) From the list of products on the Product Manager form, highlight "Soil Moisture Strength Prediction (SMSP)". Press "Select".

(4) From the list of previously created Soil Strength Analyses, select the analysis which was just created.

(5) Press "OK" to accept the selection and to continue.

(6) On the Product Manager form, press "PLOT" to display the results of the Soil Strength Analysis (Figure 87).

Figure 87. Sample soil strength analysis TDA

11 Weather Gauge/Weather Report Edits

Introduction

The Weather Gauge/Weather Report Edits Utility provides the user a capability for introducing weather data into the CAMMS-D system--that is, capabilities to add, delete, and edit weather gauges, and to update the reports of weather gauges. These weather data are then used as input by another CAMMS-D TDA, the Soil Strength Analysis TDA.

The inputs associated with this utility are as follows:

a. A weather gauge identification (ID) for each gauge.

b. The location of each weather gauge (in Military Grid Reference System (MGRS) coordinates).

c. An operational status (active or inactive).

d. Type of precipitation (snow, rain, or no report).

e. The amount of precipitation (in millimeters).

f. If snow is reported:

(1) Snow type (maritime, inland, or alpine).

(2) Snow condition (wet, average, or dry).

g. Elevation of the gauge (in meters).

h. Ground condition (frozen or not frozen).

i. Maximum visibility (in meters).

Software for this TDA analyzes weather gauge/weather report data only in the sense of editing the locations and weather data supplied by active weather gauges. These weather gauge data are then input to other CAMMS-D TDAs for use in their analyses (e.g., for use by the Soil Strength Analysis TDA).

Utilizing the Weather Gauge Utility

The following subsections provide instructions necessary to add weather gauges, update weather gauge(s), edit weather gauge(s), and delete weather gauge(s), respectively. First, some general information is provided.

A given weather gauge can be added to the weather data input system by specifying an identification (ID) for the new gauge, the location of the gauge in MGRS coordinates, and the elevation of the gauge. This information is also used when editing the weather gauges.

Weather reports include the information reported by each weather gauge (precipitation type and amount, ground condition, visibility, snow type, snow condition, etc.)

Precipitation is measured in millimeters, temperature in degrees Celsius, and terms involving long distances such as visibility and elevations in meters.

a. Add weather gauge(s)

(1) From the Display Manager main menu, select "Display" followed by "Products".

(2) From the "Product Group" list on the Product Manager form, select "Weather Effects".

(3) On the list of products appearing on this form (Figure 88), highlight "Add Weather Gauge" and press "Create".

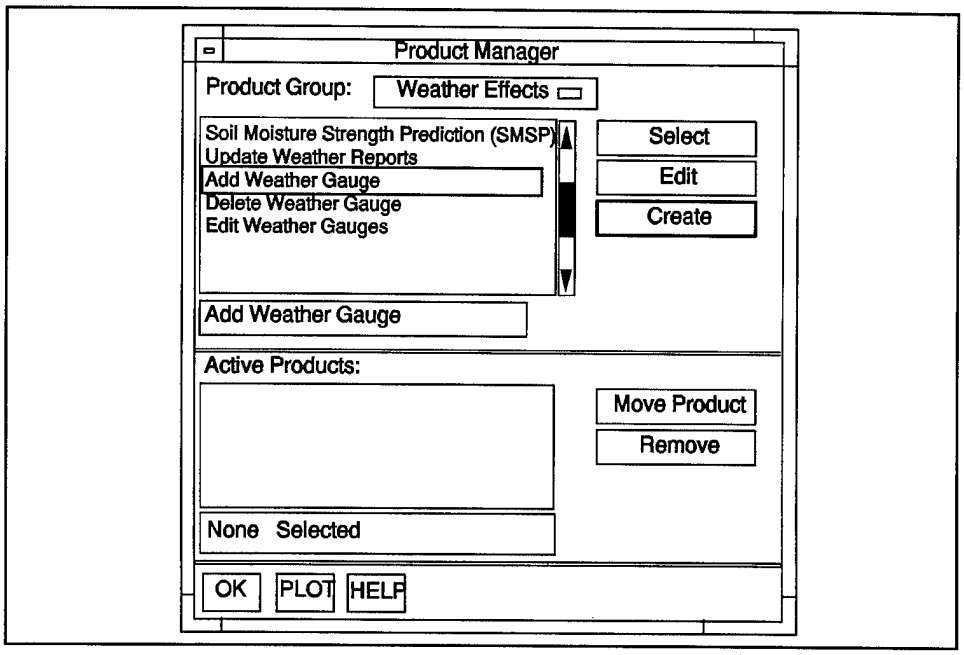

Figure 88. Product Manager form

(4) A form will appear requesting a gauge ID, the location of the gauge (MGRS), and the elevation of the gauge (in meters), as illustrated in Figure 89.

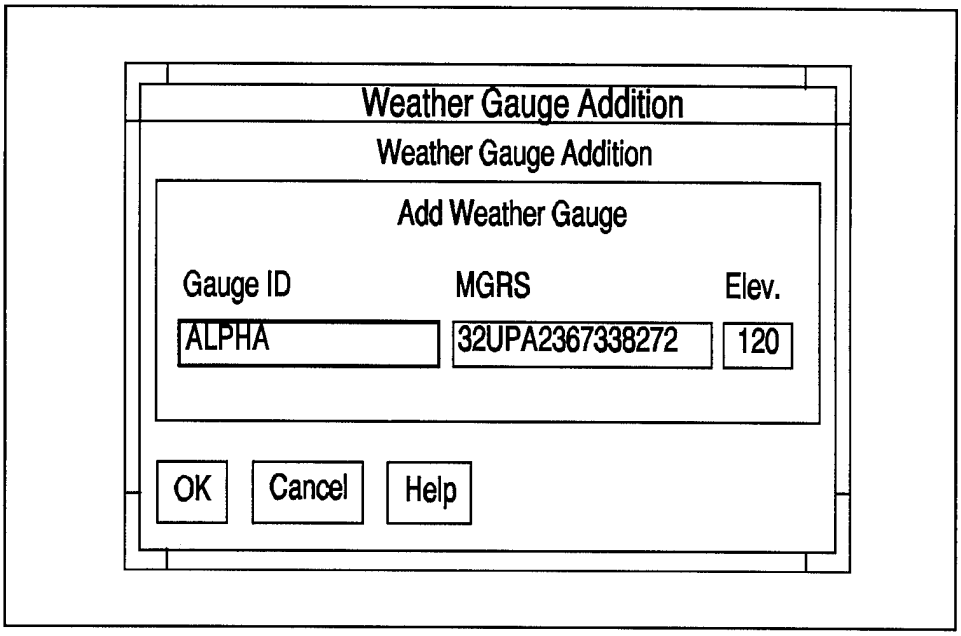

Figure 89. Weather Gauge Addition form

(5) When all the requested information has been entered into the form, press "OK".

(6) It is necessary to update the report of this newly added gauge by accomplishing steps described as follows.

b. Update weather report(s)

(1) From the Display Manager main menu, select "Display" followed by "Products".

(2) From the "Product Group" list on the Display Manager form, select "Weather Effects".

(3) On the list of products appearing on this form, highlight "Update Weather Report" (as illustrated in Figure 90), and press "Create".

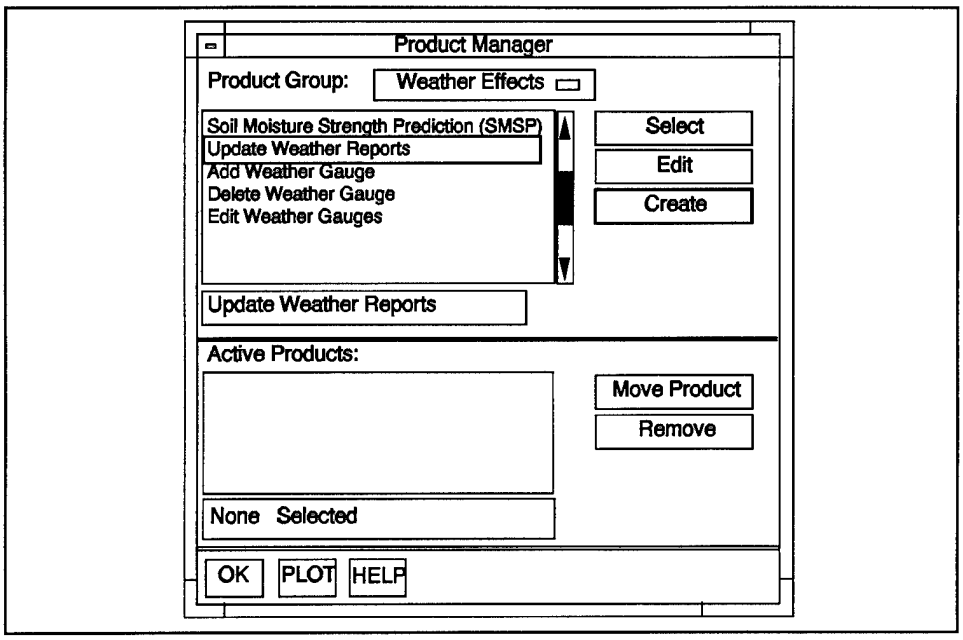

Figure 90. Product Manager form illustrating weather report update selection

(4) A form will appear allowing the user to input the current weather conditions, an example of which follows in Figure 91.

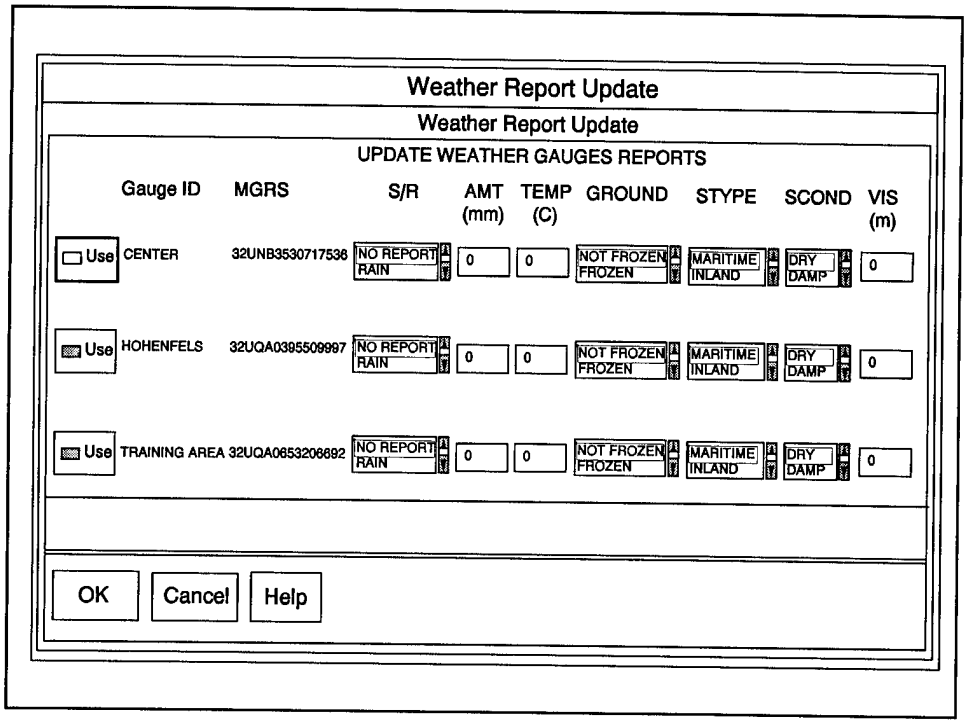

Figure 91. Weather Report Update form illustrating weather report update selection

(5) When the weather conditions have been updated, press "OK".

c. Edit the weather gauge(s)

(1) From the Display Manager main menu, select "Display" followed by "Products".

(2) From the "Product Group" list on the Product Manager form, select "Weather Effects".

(3) On the list of products appearing on this form, highlight "Edit Weather Gauges" (as illustrated in Figure 92), and press "Create".

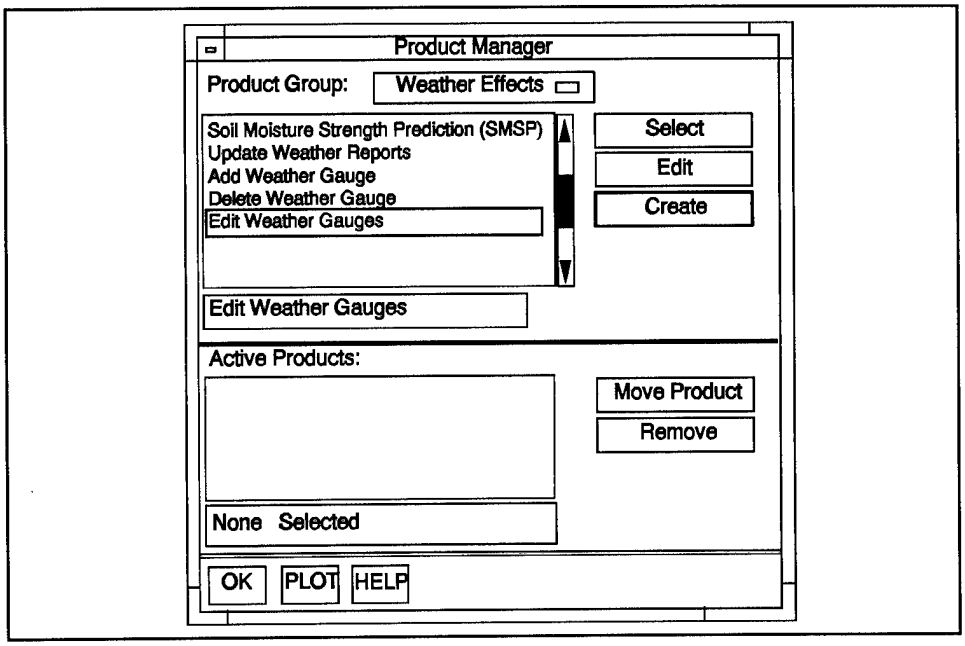

Figure 92. Product Manager form illustrating weather gauge edit option

(4) A form will appear allowing the user to edit the gauge ID, location, and elevation, an example of which follows in Figure 93.

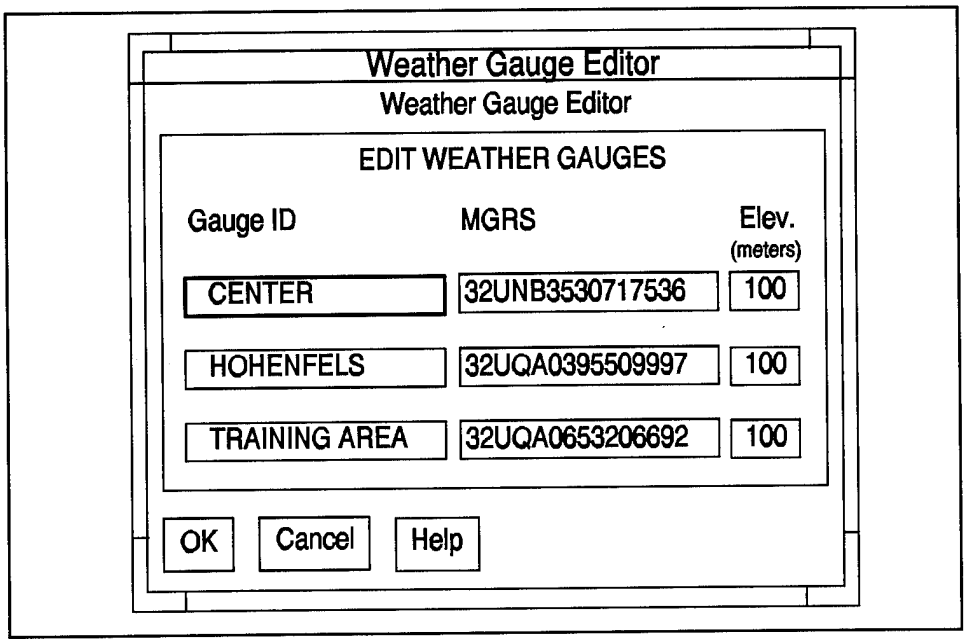

Figure 93. Weather Gauge Editor form

(5) When the requested weather gauges data have been updated, press "OK".

d. Delete weather gauge(s).

(1) From the Display Manager main menu, select "Display" followed by "Products".

(2) From the "Product Group" list on the Product Manager form, select "Weather Effects".

(3) On the list of products appearing on this form, highlight "Delete Weather Gauge(s)" and press "Create".

(4) A list of all gauges presently included in the system will appear, as illustrated in Figure 94.

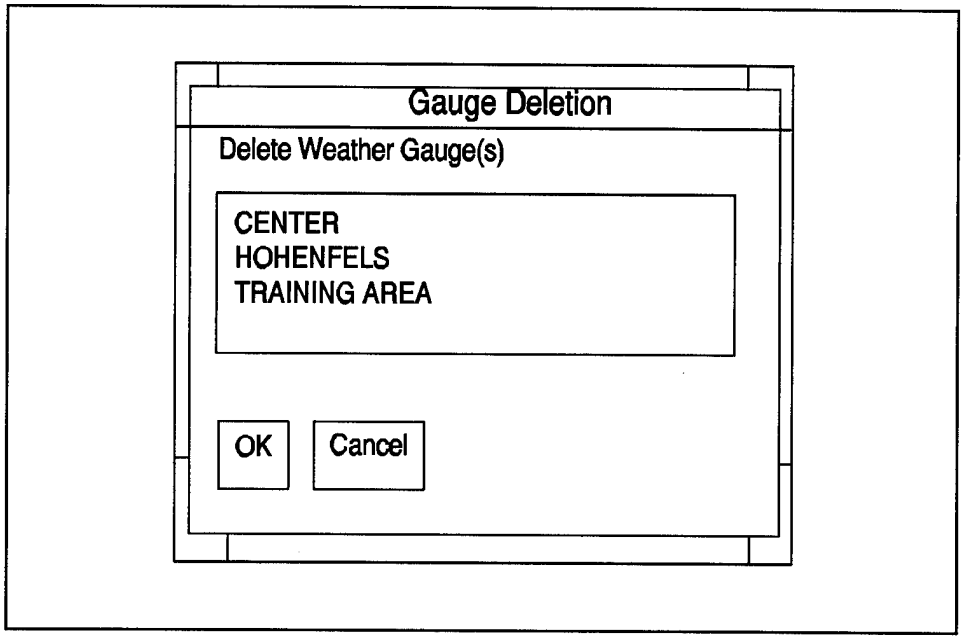

Figure 94. Weather Gauge Deletion List

(5) The user can highlight any one or more of the weather gauges for deletion, as illustrated in Figure 95. Then, press "OK" to delete the highlighted gauges and to continue.

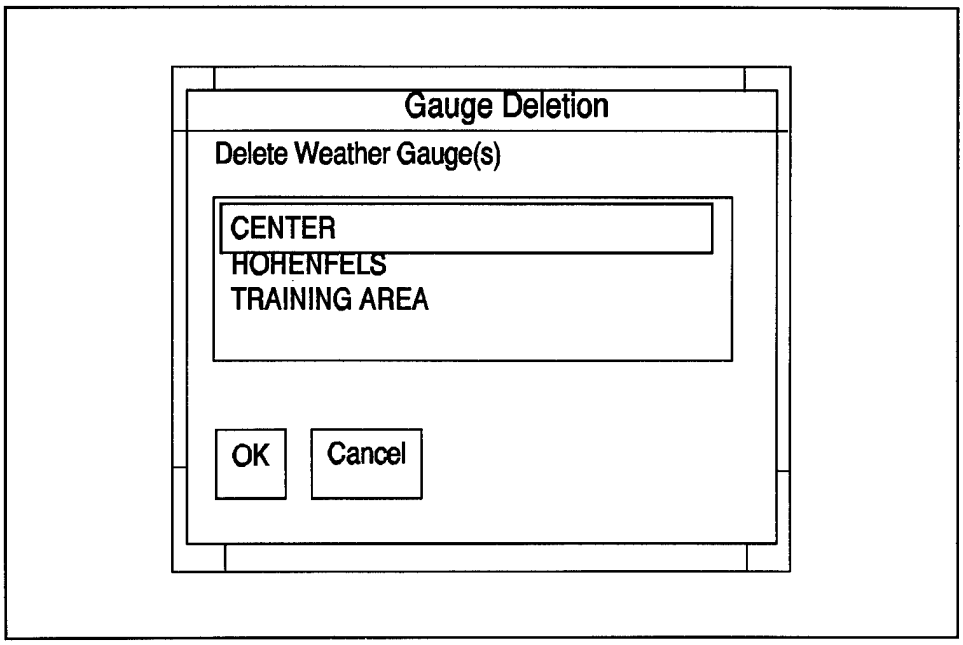

Figure 95. Weather Gauge Deletion List with one selection

Example Scenario and TDA Walk-Through

Weather gauges have been distributed throughout the area of operation. It will be necessary to use the data provided by these gauges for future risk-based ground mobility analyses. Task: Install two new weather gauges into the system. Update the report of the two gauges to correspond to the information listed below.

a. GAUGE_A 32UPA2367238271 100m elevation

(1) 125mm Rain

(2) Ground is not frozen

(3) Visibility = 110m

(4) Temp = 20°C

b. GAUGE_B 32UPA3275533920 253 m elevation

(1) 100 m Rain

(2) Ground is not frozen

(3) Visibility = 200 m

(4) Temp = 23°C

The following steps should be performed to accomplish the task defined above.

a. From the Display Manager main menu, select "Display" followed by "Products".

b. From the "Product Group" list on the Product Manager form, select "Weather Effects".

c. From the list of products appearing on this form, select "Edit Weather Gauges".

d. A form will appear allowing the user to edit the weather gauge ID, location, and elevation.

It may be necessary to add a new slot for gauges. This can be done by returning to the Products Manager form, highlighting the "Add Weather Gauge" option, and then pressing "Create".

Weather Effects software can accommodate only six weather gauges.

Any slots which are not being used can be deactivated by using the "Update Weather Report" option on the Product Manager form, or can be deleted by using the "Delete Gauge(s)" option on the same form.

e. When the weather gauge editing is complete, press "OK".

If an attempt is made to delete a weather gauge, edit a gauge, or edit a weather report when no gauges have been installed, "No Gauges Installed" will be displayed.

If the weather gauge file is full and an attempt is made to add a gauge, the error message "Maximum Number of Gauges Exceeded" will be displayed.

12 Mobility Assessment Procedures

Introduction

Mobility speed predictions, for one or more vehicles of the same type or for standard units of vehicles, are the foundation of all analyses and TDAs in the Ground Mobility product group. The menu item, Mobility Assessment, is used to generate the mobility speed predictions for a vehicle or unit for a user-defined area of interest. The Mobility Assessment procedure for the vehicles or units of interest must be performed first before the other analyses, such as route evaluation, can be conducted.

There are three types of products or TDAs produced by and listed under the Mobility Assessment category as discussed in Chapter 2: Speed Overlays, Uncertainty Overlays, and Reason Overlays. This chapter address Speed and Reason Overlays. Uncertainty Overlays are discussed in Chapter 18. Each of these products applies to a vehicle or specified units of vehicle(s) operating on-road and/or off-road and/or across rivers/streams within a specified area under specified weather and scenario conditions.

Speed Overlays are graphical representations of CAMMS-D speed predictions, i.e., mobility (speed) capabilities, for the vehicles or units specified in the Mobility Assessment. There are several risk-based Speed Overlays available, ranging from best-case (99th percentile, upper bound on maximum speed achievable) to worst-case (1st percentile, lower bound on maximum speed achievable). The menu item, Other percentiles, allows the user to specify any percentile of interest.

The idea behind displaying Speed Overlays as ranks or percentiles is to allow the user to factor risk (conservative estimates vs. nonconservative estimates) into perspectives of GO/NOGO areas by evaluating best-case, worst-case, and in-between cases. Recall that the risk-based methodology is based on the fact that there is a range in vehicle speed outcomes, not one exact outcome, for a given vehicle (or unit) operating over a specified area. Looking at several percentile overlays of the same area of interest allows the user to gain insight into the stability of the mobility characteristics. In other

words, if one region is predicted to be NOGO for the worst-case (1st percentile), is it still a NOGO for the best-case? The Conventional Overlay shows the results of the CAMMS-D predictions without the effects of driver and vehicle differences, or within terrain unit differences, or acceleration effects. It is not likely that the conventional speed overlay will match the 50th percentile (average) speed overlay because the model (i.e., conventional predictions) underpredicts at lower speeds and overpredicts at higher speeds.

Reason Overlays depict the speed controlling factor associated with NOGOs and reductions in speed for the vehicle, road, weather, and scenario conditions specified. This type of evaluation is useful in that it allows the user to determine the types of terrain or vehicle factors associated with limiting the speed of the vehicle in various areas of interest. From this overlay, one might determine that the speed controlling factor for the majority of the area given the specific vehicle(s) used is slope as opposed to soil strength.

The user inputs required by the model are:

a. The standard unit of military vehicles (U.S. Tank Battalion, U.S. Tank Company, etc.) or the single vehicle type selected from predefined files in CAMMS-D.

b. A previously performed Soil Strength Analysis (indicated by the date of the soil prediction).

c. The driver's maximum visibility under field conditions of concern, including rain, snow, and clear conditions (in meters).

d. The soil surface condition (normal or slippery).

e. Current river stage (low, average, or high).

f. Movement plans (on-road and/or off-road and/or rivers/streams).

Performing Mobility Assessments

Performing the following steps will allow the user to create a new Mobility Assessment, to edit the legend associated with the Mobility Speed Overlay, to display the results (overlay) of the Mobility Speed Overlay, to edit the legend of a previously created Mobility Reason Overlay, and to display the previously created Mobility Reason Overlay associated with the Mobility Assessment.

Creating a new Mobility Speed Assessment

To create a new Mobility Assessment, perform the following steps.

a. From the Display Manager main menu, select "Display" followed by "Products".

b. From the "Product Group" list on the Product Manager form, select "Ground Mobility".

c. From the list of products on the Product Manager form, highlight "Mobility Assessment". Press "Create".

d. A form like the following in Figure 96 will appear.

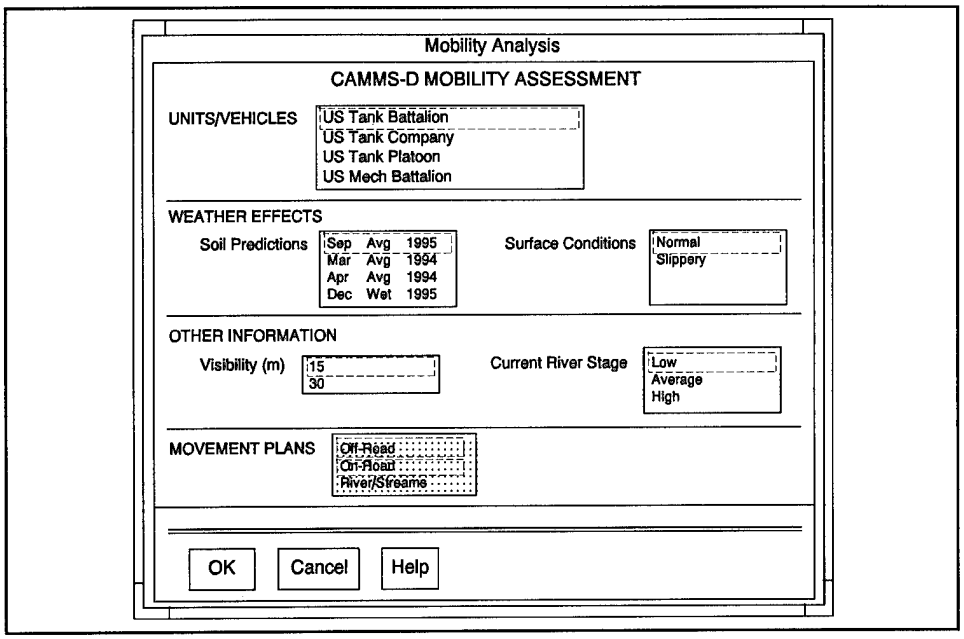

Figure 96. Mobility Assessment form

A form like that above allows the user to specify the conditions of the analysis.

e. After all fields in the form shown in *Step d* have been completed, the user should press "OK" to perform the Mobility Assessment. Pressing "Cancel" will cause the system to ignore the changes on the form and to abort the Mobility Assessment.

Editing the Mobility Speed Overlay Legend

To edit the legend of a previously created Mobility Assessment, perform the following steps.

a. From the Display Manager main menu, select "Display" followed by "Products".

b. From the "Product Group" list select "Ground Mobility."

c. From the list of products on the Product Manager form, highlight the desired Mobility Speed Overlay. Press "Edit".

d. The system will now allow the legend to be edited. Refer to information in Chapter 7 under the heading "Editing TDA Legends Capabilities" for details on this process.

Displaying a Mobility Speed Overlay

To display a previously created Mobility Speed Overlay, perform the following steps.

a. From the Display Manager main menu, select "Display" followed by "Products".

b. From the "Product Group" list on the Product Manager form select "Ground Mobility."

c. From the list of products on the Product Manager form, highlight the desired Mobility Speed Overlay. Press "Select".

d. A window containing a list of previously created mobility predictions will appear. Highlight the desired Mobility Speed Overlay.

e. Press "OK" to accept the selection and to continue. Pressing "Cancel" will cause the selection process to be aborted.

f. On the Product Manager form, press "PLOT" to display the selected overlay.

Editing a Mobility Reason Overlay Legend

To edit a previously created Mobility Reason Overlay legend, perform the following steps.

a. From the Display Manager main menu, select "Display" followed by "Products".

b. From the "Product Group" list on the Product Manager form select "Ground Mobility".

c. From the list of products on the Product Manager form, highlight "Reason Overlay". Press "Edit".

d. The system will now allow the legend to be edited. Refer to information in Chapter 7 under the heading "Editing TDA Legends Capabilities" for details on this process.

Displaying a Mobility Reason Overlay

To display a Mobility Reason Overlay, perform the following steps.

a. From the Display Manager main menu, select "Display" followed by "Products".

b. From the "Product Group" list on the Product Manager form select "Ground Mobility".

c. From the list of products on the Product Manager form, highlight "Reason Overlay". Press "Select".

d. A list of previously created Mobility Reason Overlays will appear. Highlight the desired Mobility Reason Overlay.

e. Press "OK" to accept the selection and to continue. Pressing "Cancel" will cause the selection process to be aborted.

f. On the Product Manager form, press "PLOT" to display the results of the Mobility Reason Overlay.

Example Scenario and TDA Walk-Through

The commander of your unit needs an evaluation of the capability of his tank battalion to move within all parts of the sector within which his battalion is expected to operate (off-road and on-road and across rivers/streams) for the soil strength prediction, maximum visibility, soil surface condition, and river stage corresponding to the next day's weather forecast. Your task: Utilize the Mobility Assessment TDA to provide the scenario information requested.

Creating a New Mobility Assessment

To create a new Mobility Assessment for the scenario conditions, perform the following steps.

a. From the Display Manager main menu, select "Display" followed by "Products".

b. From the "Product Group" list on the Product Manager form select "Ground Mobility".

c. From the list of products on the Product Manager form, highlight "Mobility Assessment". Press "Create".

d. Specify the scenario conditions in terms illustrated on the following form shown in Figure 97.

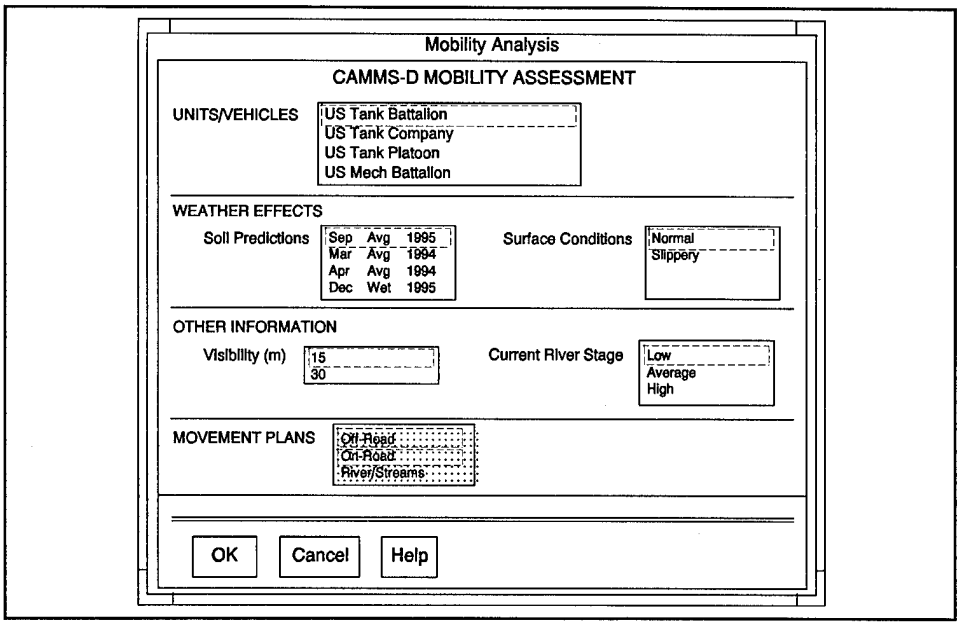

Figure 97. Mobility Assessment form for TDA walk-through

Press "OK" to continue.

e. The Mobility Assessment will be performed.

Editing the Legend of the Mobility Speed Overlay

To edit the legend of the Mobility Speed Overlay just created (or for one previously created), perform the following steps.

a. From the Display Manager main menu, select "Display" followed by "Products".

b. From the "Product Group" list on the Product Manager form, select "Ground Mobility."

c. From the list of products on the Product Manager form, highlight the desired Mobility Speed Overlay. Press "Edit".

d. The system will now allow the legend to be edited. Refer to information in Chapter 7 under the heading "Editing TDA Legends Capabilities" for details on this process.

Displaying the Mobility Speed Overlay

To display the Mobility Speed Overlay just created, perform the following steps.

a. From the Display Manager main menu, select "Display" followed by "Products".

b. From the "Product Group" list on the Product Manager form, select "Ground Mobility."

c. From the list of products on the Product Manager form, highlight the desired Mobility Speed Overlay. Press "Select".

d. A list of previously created mobility predictions will appear. Select the analysis which was just created.

e. Press "OK" to accept the selection and to continue.

f. On the Product Manager form, press "PLOT" to display the selected Speed Overlay.

You have supplied your commander a Mobility Speed Overlay (Figure 98) to aid in the commander's evaluation of the capability of his tank battalion to move within all parts of the sector within which the battalion is expected to operate. Your task: For the same vehicle, terrain, weather, and scenario conditions, your commander requests that you supply a Mobility Reason Overlay (Figure 99) to aid the commander in determining where/how to best utilize the commander's engineer support capabilities to modify/upgrade cross-country terrain, trails, bridges, etc. in the commander's operational sector so as to improve the mobility capabilities needed by his tank battalion.

To edit the legend of the Mobility Reason Overlay that was created as a by-product of the Mobility Assessment conducted in the previous scenario, perform the following steps.

a. From the Display Manager main menu, select "Display" followed by "Products".

b. From the "Product Group" list on the Product Manager form, select "Ground Mobility".

c. From the list of products on the Product Manager form, highlight "Reason Overlay". Press "Edit".

d. The system will now allow the legend to be edited. Refer to information in Chapter 7 under the heading "Editing TDA Legends Capabilities" for details on this process. Edit the legend as desired.

To display the Reason Overlay that was created as an by-product of the Mobility Speed Assessment described in the preceding walk-through, perform the following steps.

a. From the Display Manager main menu, select "Display" followed by "Products".

b. From the "Product Group" list on the Product Manager form, select "Ground Mobility".

c. From the list of products on the Product Manager form, highlight "Reason Overlay". Press "Select".

d. A list of previously created Mobility Reason Overlays will appear. Select one of the overlays.

e. Press "OK" to accept the selection and to continue.

f. On the Product Manager form, press "PLOT" to display the selected overlay.

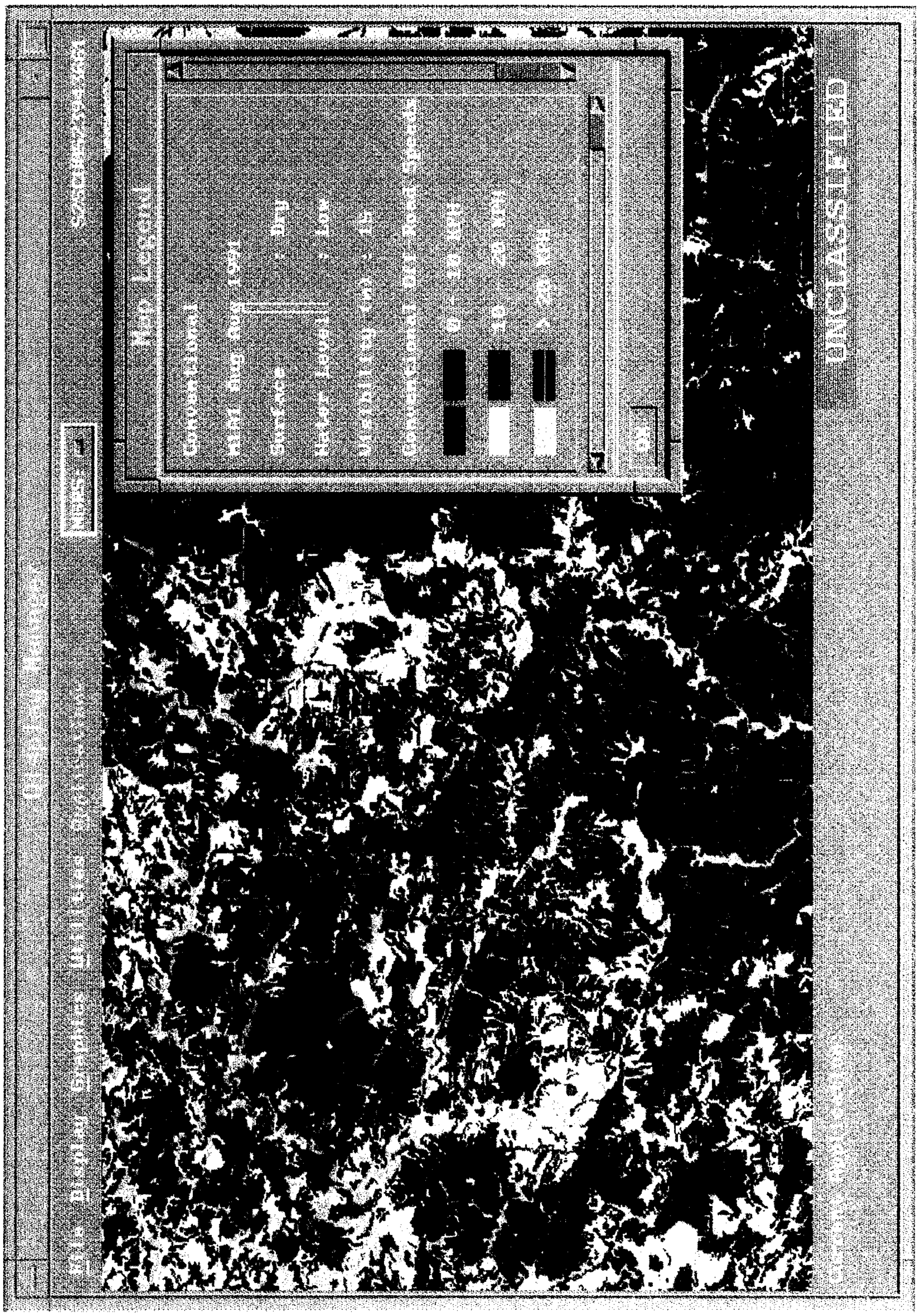

Figure 98. Sample mobility speed analysis TDA

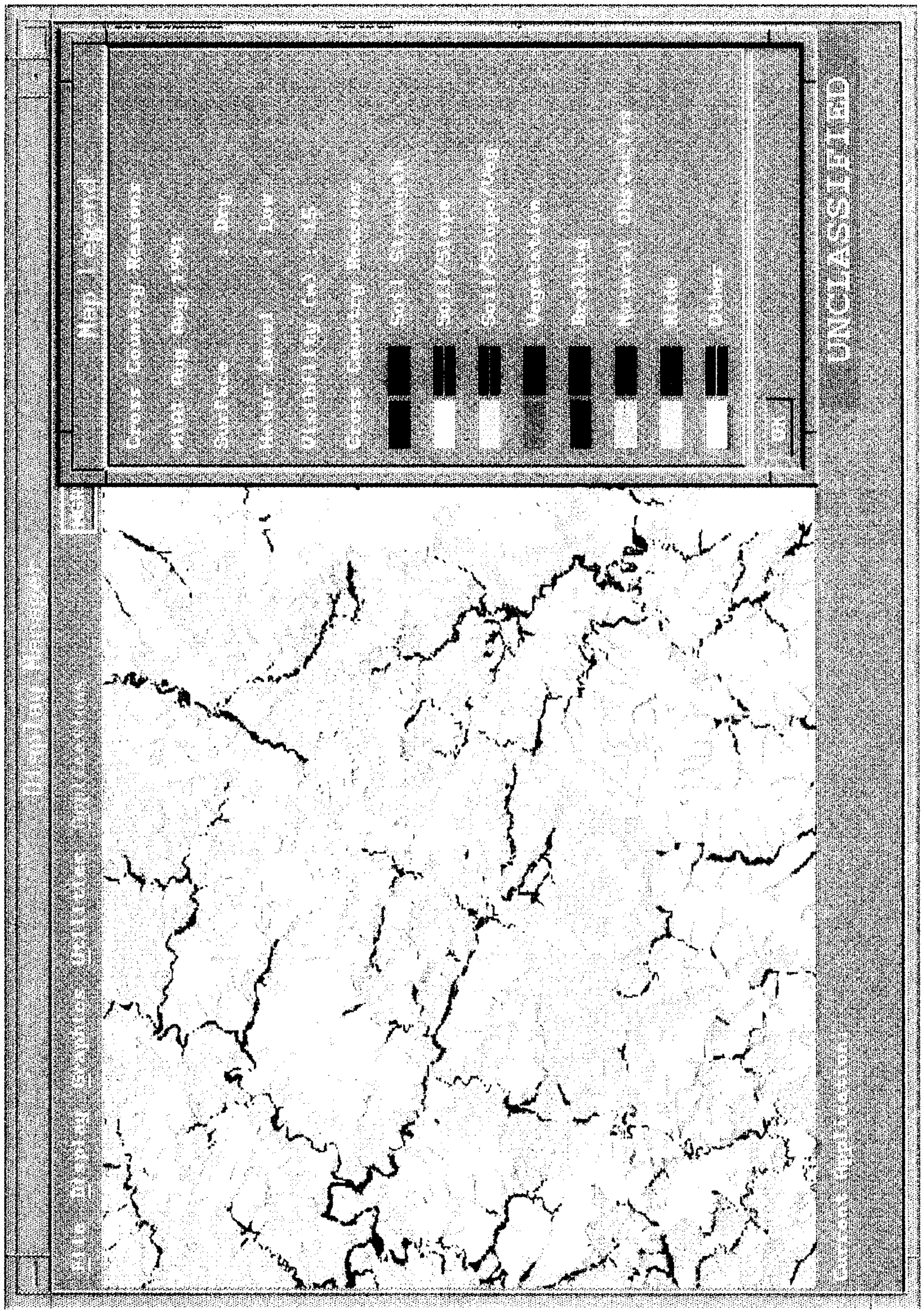

Figure 99. Sample mobility reason analysis TDA

13 Time Contour Analysis TDA

Introduction

CAMMS-D prediction provides the user a graphical output (overlay) for estimating the time of travel either for a standard unit of vehicles (tank company, mechanized battalion, etc.), or for one or more vehicles of the same type, to move outward from any user-specified location on a map to any other location on the map. The TDA can describe vehicle movements either on road and/or off road and/or across rivers/streams under specified weather conditions. The interested can refer to McKinley et al. (1993). Results of the Time Contour Analysis (TC) will be displayed on the computer screen as color-coded contours spreading outward in increasing values of elapsed travel time from a user-selected starting map location.

The travel time estimates are based on the predicted speeds produced by the Mobility Assessment procedures. Recall that the speed estimates range from best-case to worst-case bounds. Thus, the user can select conservative, average, or nonconservative speeds to use in TC Analysis. For example, speeds associated with the 25th percentile Speed Overlay will result in longer-than-average travel times. In addition, the user can opt to use random percentile speeds in computing time to travel. That is, not all speed predictions will be best-case or from the same rank (percentile). Instead, some predictions will be conservative while others will be nonconservative and so forth. This presents a good method for examining TCs that are not at the extremes.

The model requires the following user inputs:

a. *Product Identification.* This identification consists of a character string which is used to identify the time contour. This string will be used to save and to recall the time contour prediction.

b. *A Mobility Speed Analysis Prediction* . A list of Mobility Speed Analyses performed previously in the CAMMS-D system will appear on the input form. (This part of the form will show the phrase "MOBILITY ASSESSMENT" and will list the combinations of vehicle(s)/date(s) and unit(s) of vehicles/date(s) for which Mobility Speed Analyses are available.) The user is required to select one of these analyses (predictions). The user also must indicate which percentile overlay he/she desires.

c. *Movement Plans*. The user can instruct the model to use on-road data and/or off-road data and/or river/stream crossing data for the Time Contour Analysis. If on-road data are used, the user must select the type(s) of roads (superhighways and/or primary and/or secondary and/or loose surface roads) to be considered in the prediction.

d. *Maximum Speed of Unit*. For the user-specified unit of vehicles or for one or more vehicles of user-specified type, this limit can be input by the user; otherwise the default maximum speed is 167 kph. When the default maximum speed is specified, Time Contour actually constrains the vehicles to travel at much lower speeds -- i.e., at the highest speeds possible under the specified conditions of vehicles(s) or unit(s) of vehicles/terrain/weather/scenario for the many individual cells of the map. The value of the default speed can also be altered by the user to correspond to a given speed limitation placed on the vehicle(s) or unit(s) of vehicles for any reason--e.g., to correspond to the maximum on-road speed specified by the commander's standard operating procedure for moving a given unit of vehicles (say, 60 kph).

For each user-specified vehicle unit or for vehicle(s) of a user-specified type, the Time Contour software evaluates the effects on vehicle mobility of all significant vehicle characteristics (vehicle weight, geometry, tractive force capabilities, etc.), all significant terrain factors (vegetation type and spacing, soil strength, ground surface roughness, slope, etc.), and appropriate features of current or forecast weather. From these inputs, Time Contour produces predictions of speed capability, using the specified speed predictions, either for the specified unit of vehicles or for vehicle(s) of specified type for any point on a given map. Further Time Contour Analysis then predicts the shortest times for the user-specified vehicle unit or for the vehicle(s) of user-specified type to move outward from a user-specified location to all other locations on the map.

Utilizing the Time Contour Analysis TDA

The following steps instruct the user how to create a Time Contour Analysis and how to display a previously created Time Contour Analysis.

Creating a Time Contour Analysis Overlay

To create a Time Contour Analysis overlay, perform the following steps.

a. From the Display Manager main menu, select "Display" followed by "Products".

b. From the "Product Group" list on the Product Manager form, select "Ground Mobility".

c. A list of products will appear on the Product Manager form. Select (highlight) "Time Contour Analysis" and press "Create".

d. The system will prompt for definition of a contour area. With the mouse, select up to a maximum of ten points of a polygon to define the perimeter of the area of interest. All points must fall within the AOP boundary.

e. Press "OK" when all of the points have been defined to close the polygon. (If the maximum of ten points is selected, there is no need to press "OK"; the system will automatically close the polygon).

f. The system will prompt for a starting point. With the cross-hairs, select a starting point for the vehicle (or unit) by clicking the left mouse button when the crosshairs are in the user-selected starting position, within the user-defined search area.

g. A form will appear requesting the information, illustrated in Figure 100. When information input to the form is completed, press "OK" to continue.

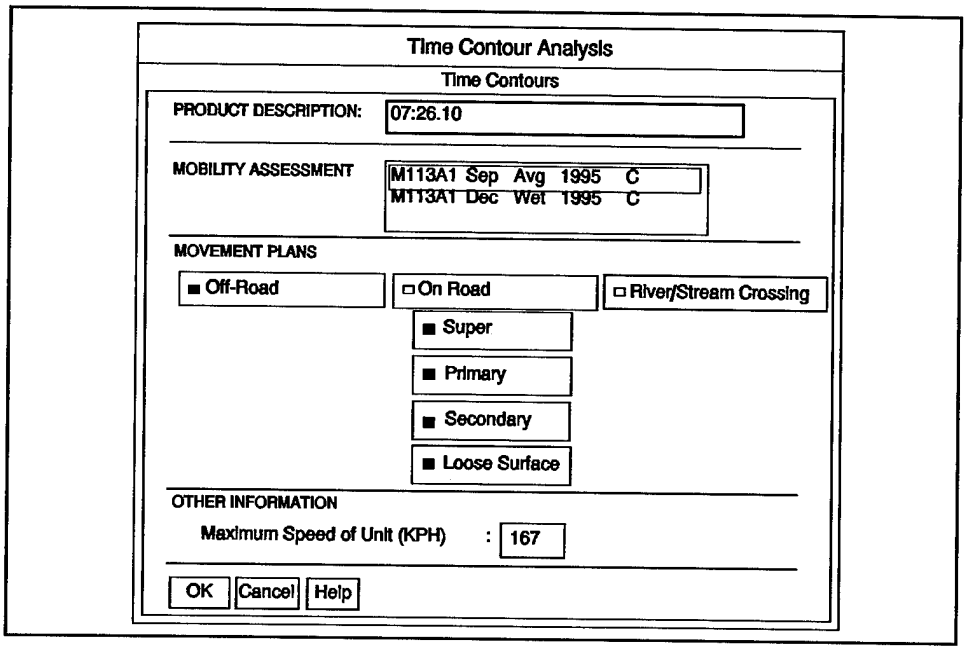

Figure 100. Time Contour Analysis form

h. The system will ask the user if he/she wishes to use simulated speeds. "Simulated Speeds" refers to the probabilistic calculations. If the user presses "Cancel", the model will use the conventional speed predictions; however, if the user presses "OK", the model will prompt the user to select from randomly selected speeds, conventional speeds, or one of the percentile speeds. Once the selection is made and "OK" is pressed, the analysis will begin.

i. When the Time Contour Analysis is complete, a message will appear so indicating.

j. Press "OK" to continue. This will also remove the Time Contour Analysis from memory.

Displaying a Time Contour Analysis Overlay

To display a Time Contour Analysis, perform the following steps.

a. From the Display Manager main menu, select "Display" followed by "Products".

b. From the "Product Group" list on the Product Manager form, select "Ground Mobility"

c. A list of products will appear on the Product Manager form. Highlight "Time Contour Analysis" and press "Select".

d. The system will display a list of previously created Time Contour Analysis. Highlight one of the items in the list and press "OK". "Time Contour Analysis" will appear on the active products list on the Product Manager form.

e. To plot the active products, press "PLOT". The Time Contour Analysis will be plotted.

f. Once the Time Contour Analysis is complete, it is necessary to return to the Product Manager form if the user desires to remove this product from the list of active products. This can be accomplished by highlighting the Time Contour Analysis entry in the active products list and pressing "Remove".

Example Scenario and TDA Walk-Through

A unit of threat vehicles has been spotted at Position A. Your unit's commander needs a Time Contour Analysis overlay to determine the capabilities of this threat unit to move outward in any direction from Position A. The commander does not want to underestimate the threat's capabilities. Your task: Utilize the Time Contour Analysis TDA to provide the needed overlay.

The following steps are required to complete the assigned task:

a. From the Display Manager main menu, select "Display" followed by "Products".

b. From the "Product Group" list on the Product Manager form, select "Ground Mobility."

c. Highlight "Time Contour Analysis" and press "Create".

d. Select up to ten points of a polygon to define the perimeter of the area of interest.

e. Press "OK" when all points of the polygon have been defined.

f. Locate starting point A for the unit of threat vehicles.

g. A form will appear requesting information on particulars to be used in the analysis of speed of the threat vehicle unit. Provide the information requested and press "OK" to continue. Press "OK on the "Simulated Speeds" window and select the 90th percentile overlay. The system will perform a Time Contour Analysis.

h. When the analysis is complete, the system will issue a "Time Contour Analysis Completed" message and a time contour overlay will be displayed as shown in Figure 101.

i. Press "OK" to continue.

j. Return to the Product Manager form to display the results with a legend. (Note: the 90th percentile overlay is composed of high estimates).

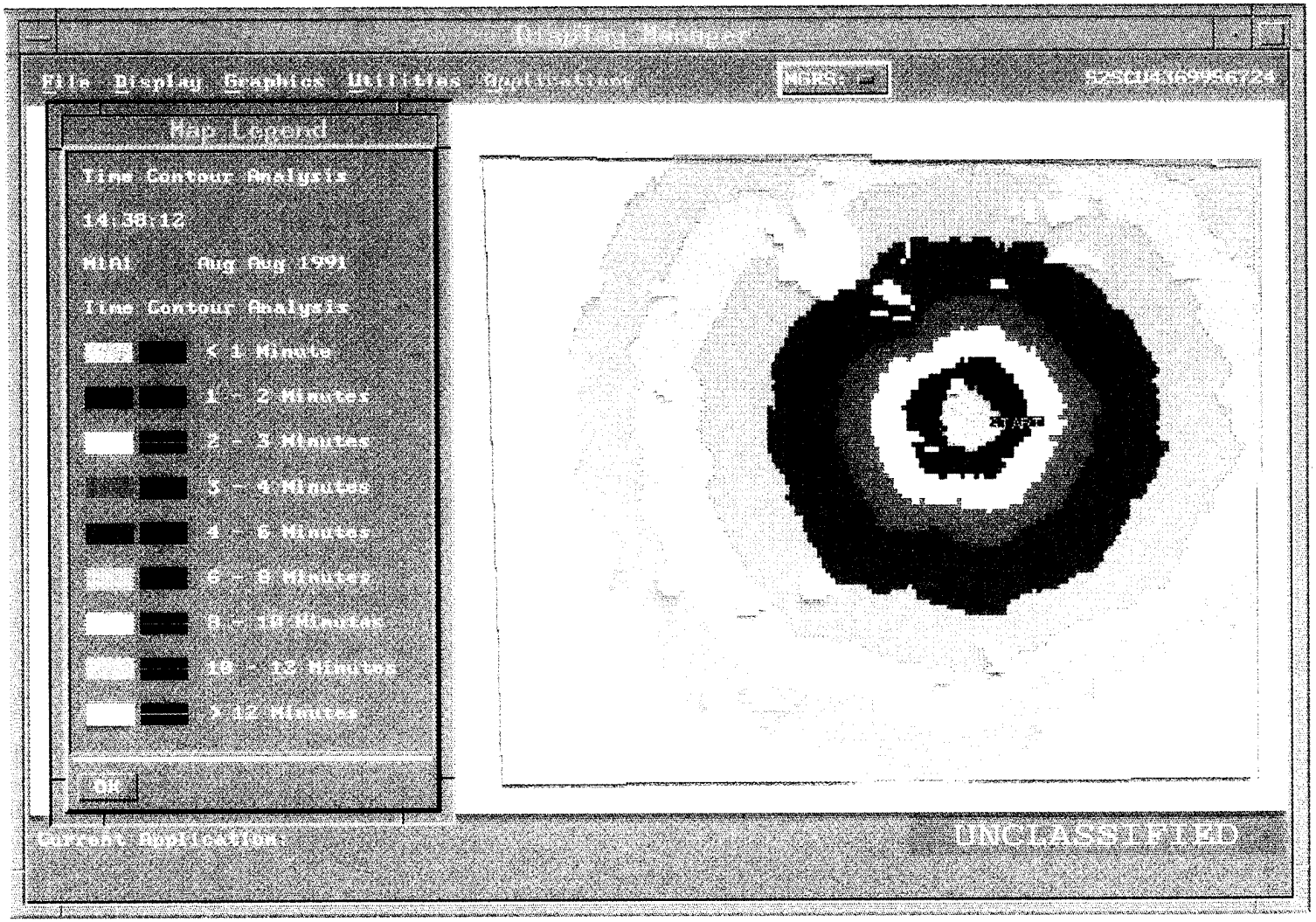

Figure 101. Sample time contour analysis overlay

14 Mobility Corridors TDAs

Introduction

Two risk-based Mobility Corridors (MC) TDAs are implemented within CAMMS-D: the automated MC TDA and the user defined MC TDA. The automated MC TDA employs computer algorithms to find the best (generally fastest) mobility corridors between two points and within a specified region for a given vehicle or unit of vehicles for various input parameters. The user defined MC TDA, on the other hand, computes a travel time window based on selected high and low speed percentile overlays associated with a route designated by the user. The user defined application allows the user to evaluate and compare various routes chosen based on experience or other intangible factors. In computing the traverse time, the automated application also takes advantage of being able to factor in risk by allowing the user to select either conventional speed predictions or percentile-based speed predictions. Thus, if the 50th percentile Speed Overlay is selected as the basis for selecting an automated MC, the average speeds associated with each terrain unit will be used to determine the fastest route. The automated procedures do not compute maximum and minimum travel times associated with the resulting route as do the user defined procedures; however, this information can be obtained using the ETA procedures discussed in Chapter 15.

The MC TDA (Automated), based on predictions by CAMMS-D, supplies the user with a graphical product (overlay) useful for providing assistance in selecting the best mobility corridors for a user-specified set of input values that describe the situation of interest. Input values include the unit(s) of vehicles; whether travel is on-road and/or off-road and/or across rivers/streams; how to travel through urban areas; weather; terrain area of interest, etc.; and several parameters that define conditions of the mobility corridor(s). The inputs related to the corridors include number of corridors; starting, intermediate, and ending points; whether corridors are shared; and rules for movement of groups of vehicles within corridor(s). For more details on the algorithm employed, refer to McKinley et al. (1993). More specifically, the following inputs are needed.

a. *Product Identification (ID).* This identification consists of a character string to be used later in identifying the mobility corridor to be selected by the CAMMS-D system.

b. *Mobility Assessment.* A list of Mobility Assessments performed previously in the CAMMS-D system will appear on the Mobility Corridors input form. (This part of the form will show the phrase "MOBILITY ASSESSMENT" and will list the combinations of vehicles(s)/date(s) and unit(s) of vehicles/dates for which speed predictions are available.) The user is required to select one of these analyses (predictions).

c. *Movement Plans (On-road data and/or Off-Road data and/or River/Stream data).* If on-road data are to be considered during the Mobility Corridors analysis, the user must choose the type(s) of roads (superhighways and/or primary roads and/or secondary roads and/or loose surface roads) to be considered.

d. *Number of Corridors.* The number of corridors to be selected (1, 2, or 3) must be specified by the user.

e. *Maximum Speed of Unit (kph).* For the user-specified unit(s) of vehicles, the maximum speed at which the unit of vehicles will travel can be specified by the user; otherwise, the upper limit default speed used by this TDA is 167 kph. If the default speed is selected, MC will actually allow the unit(s) of vehicles to travel at much lower speeds--i.e., at the highest speeds possible for the many individual cells of the map under the specified conditions of vehicle unit(s)/ terrain/weather/ Mobility Corridors scenario.

f. *Maximize Urban Mobility (Yes or No).* If the user selects Yes, the system will allow the unit(s) of vehicles to travel at relatively high speeds (greater than 20 kph); if No, the vehicle will be allowed to travel only at relatively low speeds (less than 20 kph).

g. *Compute Sharing Corridors (Yes or No).* If this option is selected, the system will allow a given corridor to share a portion of another corridor.

h. *Attempt to Avoid Choke Points (Yes or No).* If the user selects Yes, MC will compute corridor(s) that avoid choke points (areas of likely congestion due to terrain factors, width(s) of corridor(s), etc.); if No, MC will not take choke points into consideration.

i. *Compute Times Along Corridor(s) (Yes or No).* If the user selects Yes, MC will compute travel times every 5 kilometers along the corridor(s); if No, MC will not compute intermediate travel times along the corridor(s).

j. *Area of Consideration.* The system will prompt the user to graphically select a polygon that defines the boundary of the search area for the selection of the corridor(s).

k. *Starting Point, Ending Point, Intermediate Points.* The user must graphically select a starting point, an ending point, and up to eight intermediate points along the route.

l. *Convoy Unit Movement.* The following information defining roles of movement is required:

(1) Convoy movement formation (open or closed).

(2) Average number of vehicles per convoy.

(3) Space between convoys (minutes).

(4) Travel time between rest stops (minutes).

(5) Length of rest stops (minutes).

A graphical display (overlay) of the results of the Mobility Corridor(s) selection(s) is provided for the user to view the results.

The MC TDA (User Defined) allows the user to select a mobility corridor via the mouse. Once the corridor selection is complete, the TDA will determine a minimum time and a maximum time required to traverse the selected corridor. The user is required to select a mobility speed analysis and the desired percentile overlays which will be used to perform the minimum and maximum time calculations.

Utilizing the Mobility Corridors (Automated) TDA

The following steps instruct the user how to create a Mobility Corridor analysis.

a. From the Display Manager screen, select "Display" followed by "Products".

b. From the "Product Group" list on the Product Manager form, select "Ground Mobility."

c. From the list of products, select (highlight) "Mobility Corridors (Automated)". Press "Create".

d. Begin selecting points of the polygon which defines the boundaries of the desired search area. When all points are selected, press "OK". The polygon defining the search area will be displayed. A maximum of ten points is allowed. If ten points are selected, there is no need to press "OK". All points must be within the AOP.

e. Select the starting point, zero to eight intermediate points, and the ending point of the corridor(s). Press "Cancel" when all desired points have been chosen if that number is less than ten. If ten points are selected, there is no need to press "Cancel". All points must be within the user-defined search area.

f. A form will appear requesting information illustrated in Figure 102. When information input to the form is completed, press "OK" to continue.

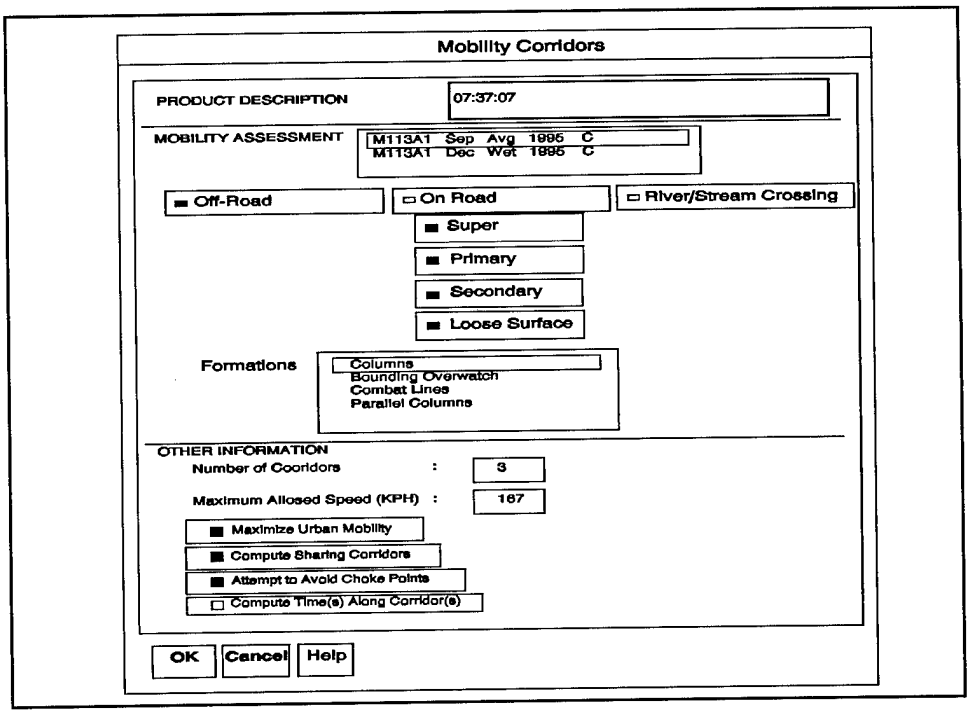

Figure 102. Mobility Corridors (Automated) form

g. A message will appear asking the user if he/she wishes to use "Simulated Speeds"; this refers to a risk-based mobility assessment. If the user presses "Cancel", the model will use the conventional speed predictions; however, if the user presses "Continue", the model will prompt the user to select from randomly selected speeds, conventional speeds, or one of the percentile speeds. Once the selection is made and "OK" is pressed, the analysis will begin.

h. Under some conditions a second form, the Convoy Unit Movement form, will appear, illustrated in Figure 103.

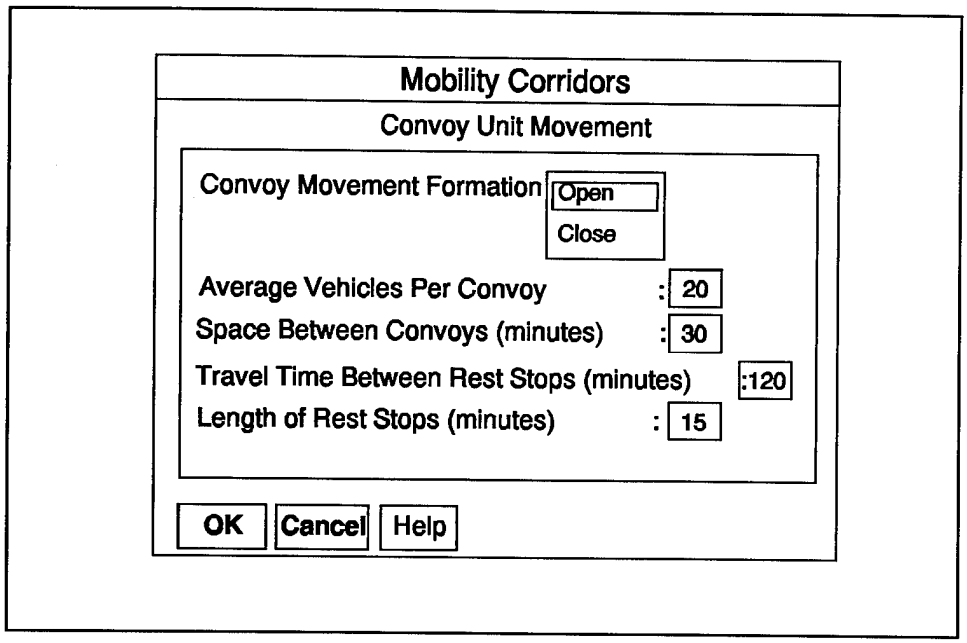

Figure 103. Convoy Unit Movement form

When entries to the form have been completed, press "OK".

i. When the Mobility Corridors computations are completed, the results will be displayed. A small window will appear informing the user of completion. When this window is removed, the corridor(s) are removed from memory, but are saved for later use as a product.

Utilizing the Mobility Corridors (User Defined) TDA

The following step instruct the user how to manually define a mobility corridor for evaluation by the system.

a. From the Display Manager screen, select "Display" followed by "Products".

b. From the "Product Group" list on the Product Manager, select "Ground Mobility".

c. From the list of products, select (highlight) "Mobility Corridors (User Defined)". Press "Create".

d. Highlight the desired mobility speed analysis and press "OK".

e. Highlight the percentile overlays to be used as the minimum speed overlay and the maximum speed overlay and press "OK".

f. Using the mouse and the left mouse button, select various points defining the desired mobility corridor. Press "OK" when all desired points have been selected. Press "Cancel" to abort the TDA.

g. The system will evaluate the corridor and display the results as shown in Figure 104.

Example Scenario and TDA Walk-Through

From a specified starting location, the locations of three objectives have been established for the advance of a friendly armored column. Your task: Using the CAMMS-D system, find the best two Mobility Corridors (in terms of time of travel) for this armored column to reach its objectives. Routes should have a low risk of immobilization (less than 25% chance of NOGO on any terrain unit).

Steps in utilizing the Mobility Corridors (Automated) TDA to accomplish the above task are as follows:

a. From the Display Manager screen, select "Display" followed by "Products".

b. From the "Product Group" list on the Product Manager form, select "Ground Mobility."

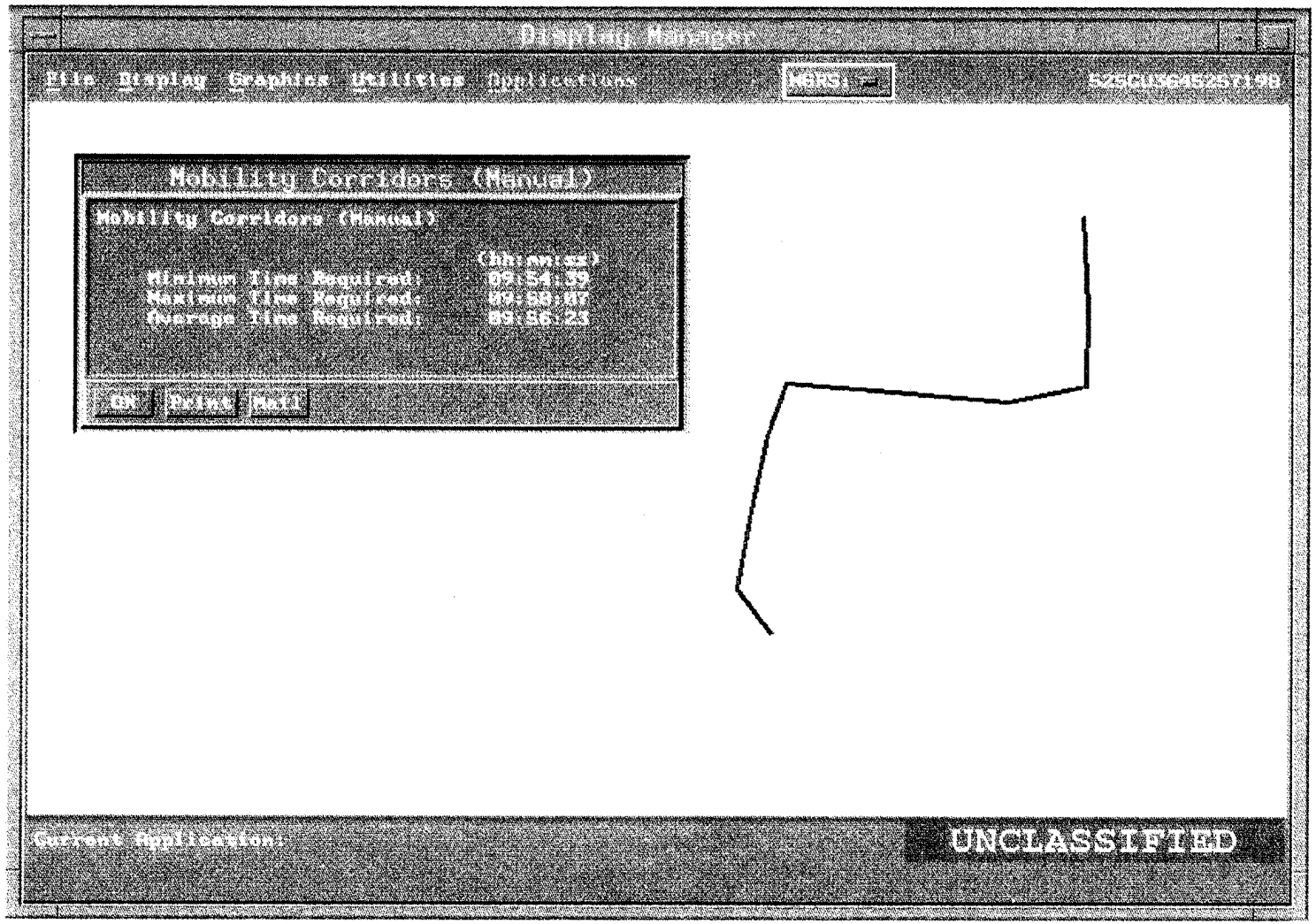

Figure 104. Sample mobility corridors (user defined) TDA

c. The Product Manager form will appear. From the list of products, select (highlight) "Mobility Corridors (Automated)" (Figure 105). Then press "Create".

d. Begin selecting the points of a polygon which defines the desired search area. When all points are selected, press "OK".

e. Select the starting location and the locations of the three objectives. Press "Cancel" when all four locations have been chosen.

f. A Mobility Corridors form requesting information will appear. Enter information relative to this example scenario. When information input to this form is completed, press "OK".

g. Press "OK" at the "Simulated Speeds" prompt. Select the 25th percentile for use as your Speed Overlay.

h. A Convoy Unit Movement form requesting information may appear When input information to this form is completed, press "OK".

i. The best two Mobility Corridors will be computed and displayed. Press "OK" to remove the corridors from memory.

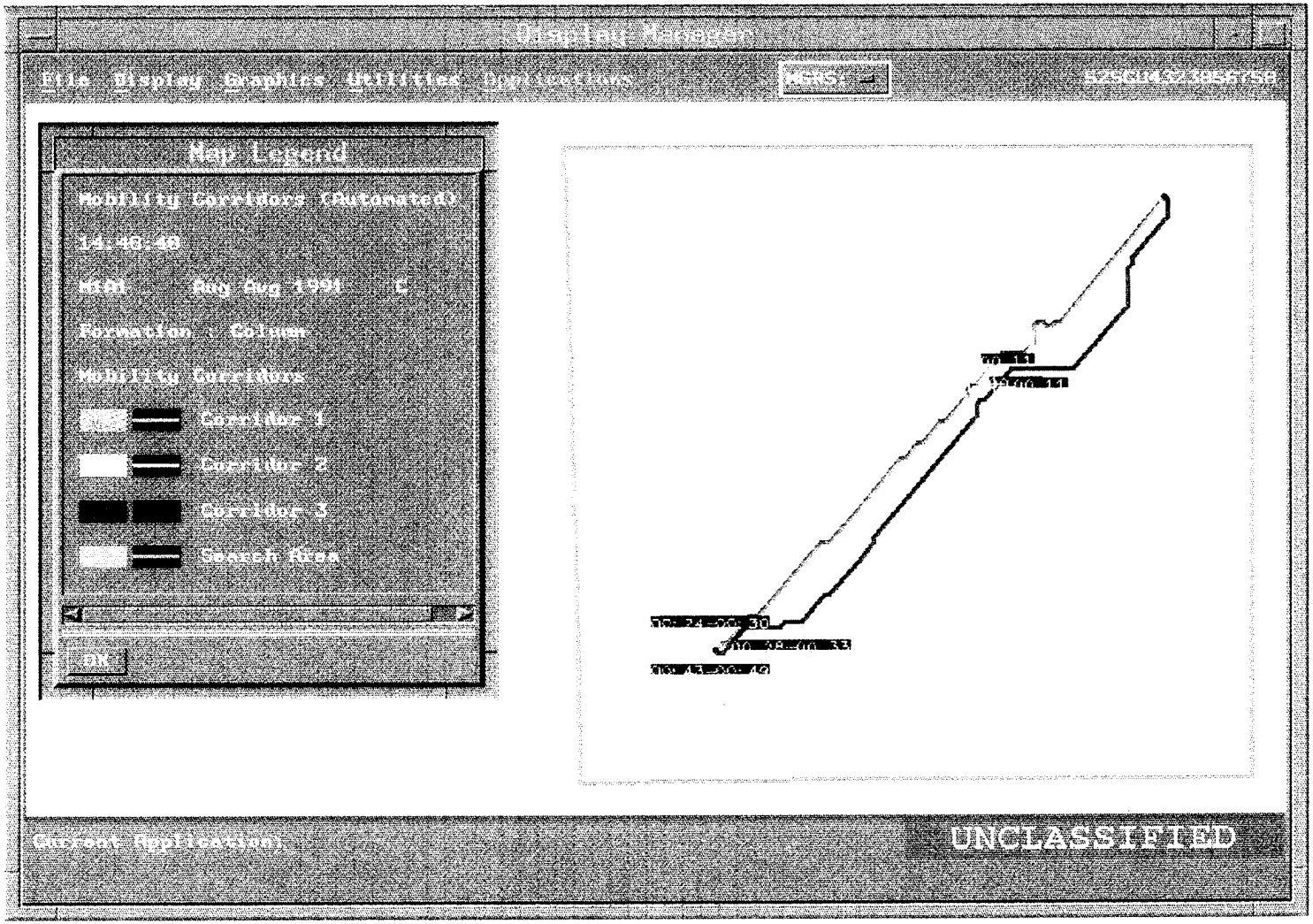

Figure 105. Sample mobility corridors (automated) TDA

15 Estimated Times of Arrival (ETA) TDA

Introduction

The ETA TDA provides a tool for estimating a time window for the traversal of a mobility corridor. In other words, the TDA estimates a minimum time and a maximum time required to traverse up to three previously created mobility corridors, based on speeds predicted by the CAMMS-D risk-based mobility model. The model accomplishes this by performing an analysis of the corridors over a CAMMS-D low speed (worst-case) overlay and over a CAMMS-D high speed (best-case) overlay, both selected by the user. For example, the 5th percentile Speed Overlay and the 95th percentile Speed Overlay may be selected as the worst case and the best case, respectively.

Upon completion of its analysis, the TDA will display the minimum, maximum, and average time required for traversing each corridor and an overall summary of the results.

Utilizing the ETA TDA

The following steps are necessary for utilizing the ETA TDA.

a. Select the Ground Mobility product group on the Product Manager form.

b. Highlight "Estimate Time of Arrival (ETA)" and press "Create".

c. Highlight the desired Mobility Corridor prediction and press "OK". If the desired prediction is not available, press "Cancel" to exit the TDA. Return to the "Mobility Corridors (Automated)" TDA to produce the desired prediction. Pressing "Cancel" at any given opportunity during the execution of the ETA TDA will end its execution.

d. Select the desired speed prediction.

e. Specify the worst case and the best case overlays to be used in the evaluation. Two items must be selected from this list. Once "OK" is pressed, the evaluation will continue.

f. Upon completion of its analysis, the TDA will display a window similar to the following shown in Figure 106.

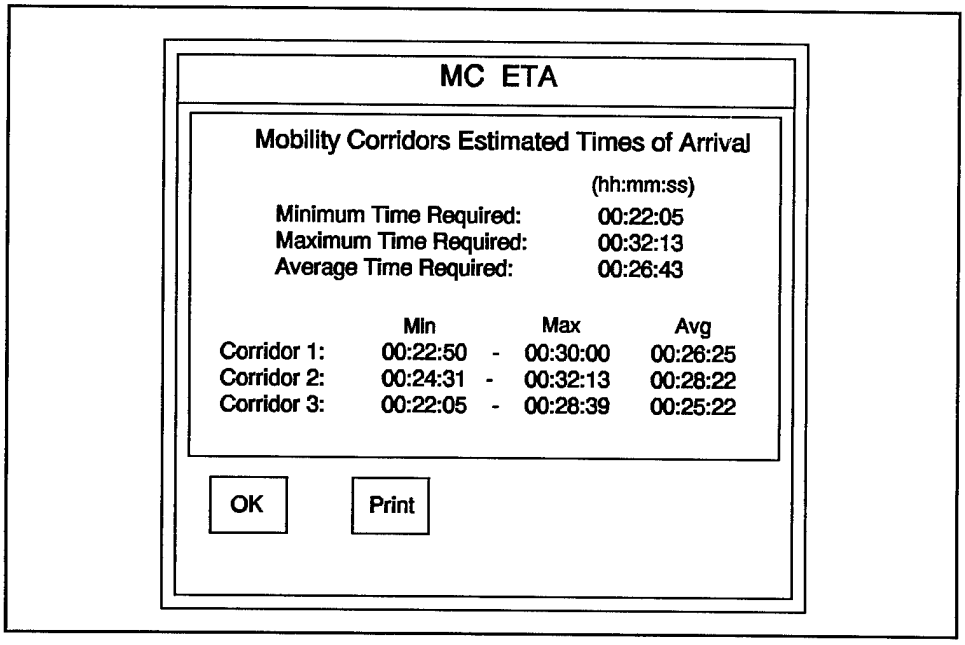

Figure 106. Sample ETA results

Example Scenario and TDA Walk-Through

A corridor has been determined for a T80 tank by the "Mobility Corridors (Automated)" TDA. Your commander wants to know what is the minimum amount of time which the T80 could traverse this corridor.

Steps to produce the desired answer are:

a. Ensure that the desired speed prediction and Mobility Corridor exist by utilizing the PM capabilities before continuing.

b. Select the Ground Mobility category on the PM Window.

c. Highlight "Estimate Time of Arrival (ETA)" and press "Create".

d. Highlight the desired Mobility Corridor prediction and press "OK".

e. Select the desired speed prediction.

f. Specify the worst case and the best case overlays to be used in the evaluation. For this example, use the 25th percentile overlay and the 75th percentile overlay.

g. Press "OK" to begin the evaluation.

These steps will result in lower and upper bound estimates on the travel time for the T80 as shown in Figure 107.

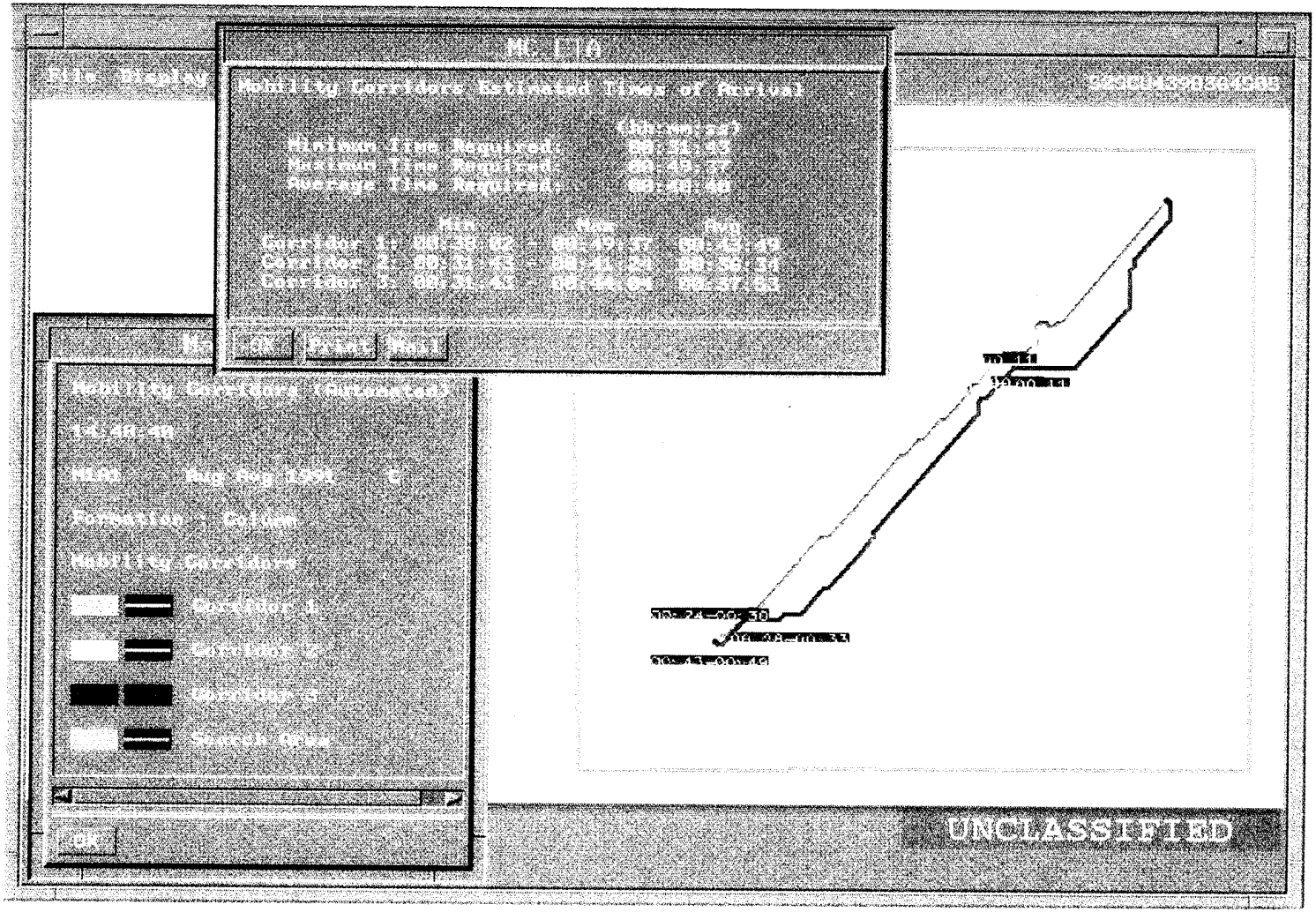

Figure 107. Sample ETA TDA

16 Named Areas of Interest (NAI) TDA

Introduction

The NAI TDA provides a tool for determining areas most likely to experience ground vehicle movements. Standard operation of the TDA requires that the user perform several mobility corridor analyses by using different Speed Overlays, such as various percentile overlays or random Speed Overlays. The NAI TDA will display areas in which various numbers of mobility corridors overlap, thus indicating the a high likelihood of vehicle operations.

For inputs, the user is required only to select the mobility corridors pertinent for this analysis. The result of this analysis is a gridded overlay containing cells colored according to the number of corridors passing through the cell.

Utilizing the NAI TDA

Steps to utilize the ETA TDA are:

a. From the Product Manager (PM) form, select the Ground Mobility product group.

b. Highlight the "Named Areas of Interest (NAI)" entry in the products list and press "Create".

c. Highlight the desired Mobility Corridor(s) and press "OK"; the analysis will begin.

d. When the TDA has completed its analysis, a form will appear requesting information for labeling the product. Figure 108 is an example.

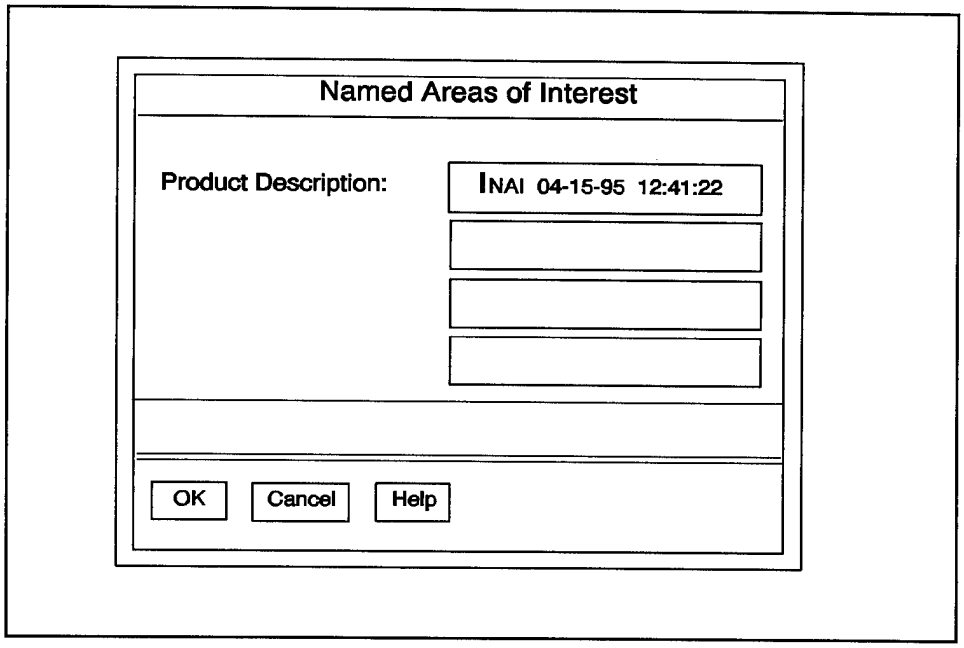

Figure 108. Named Areas of Interest form

e. To display the results of the analysis, highlight the "Named Areas of Interest (NAI)" entry in the products list and press "Select". Highlight the recently created prediction and press "OK".

f. Utilize the legend editing capabilities to tailor the display to your needs.

Example Scenario and TDA Walk-Through

To assist in fortifying defenses against an advancing threat force, your commander wishes to know areas within which these forces are most likely to move. Steps to perform this task are as follows.

a. Ensure that the desired Mobility Corridor predictions have been performed to suffice your needs. It may be beneficial to create 3 or 4 predictions from the same starting point to the same ending point by using randomly generated speed overlays.

b. From the Product Manager (PM) form, select the Ground Mobility product group.

c. Highlight the "Named Areas of Interest (NAI)" entry in the products list and press "Create".

d. Highlight the desired mobility corridors and press "OK".

e. When the TDA has completed its analysis, complete the form for labeling the product.

f. To display the results of the analysis, highlight the "Named Areas of Interest (NAI)" entry in the products list and press "Select". Highlight the recently created prediction and press "OK". (See Figure 109).

g. Utilize the legend editing capabilities to tailor the display to your commander's needs.

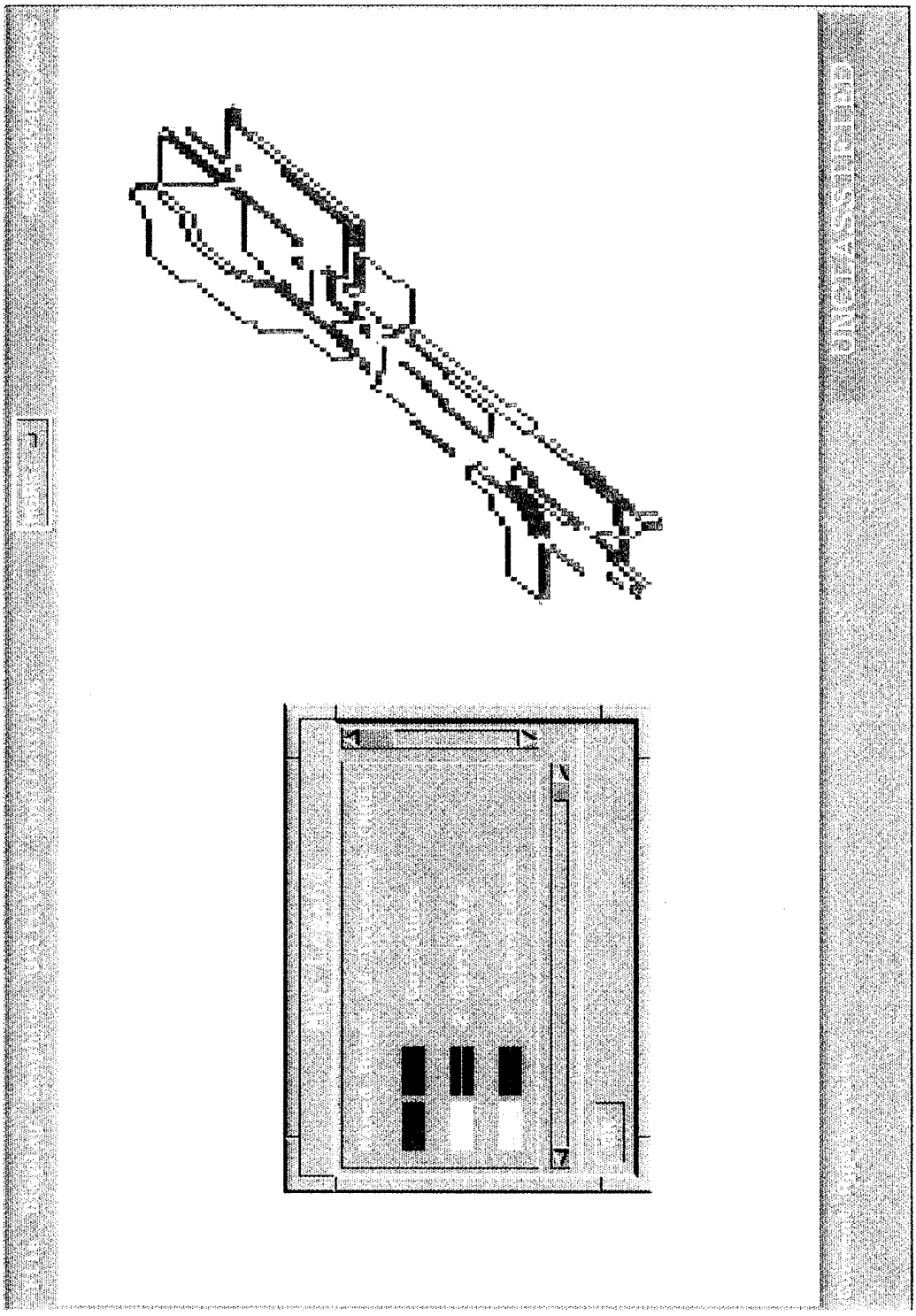

Figure 109. Sample NAI TDA

17 Facility Location TDA

Introduction

The Facility Location (FL) TDA provides a tool for selecting sites to provide maximum coverage of the area of interest, with the fewest number of facilities possible, within a specified time constraint. Example uses of the FL TDA include locating medical support units and ammunition supply points and establishing divisional base camps.

The FL TDA selects candidate sites based on suitability for use. Criteria for candidacy, as determined by the TDA developers, include soil type, vegetation, slope, natural obstacles, and relation to urban areas and bodies of water. The user is able to factor in risk, i.e., consider best- versus worst-case, by selecting the speeds associated with desired percentile overlays to use in determining area coverage. After the user has selected a mobility speed prediction, and has specified the desired time constraint (maximum response time), the FL TDA begins to evaluate a random sampling of candidate sites and determines the number of facilities needed to provide maximum coverage. Once the number of sites needed is determined, the model will search for a solution. This search is performed by randomly selecting candidate sites, performing a time contour analysis from each, and tallying the coverage provided. The random search will continue until the model has not found better results in a predetermined number of attempts. A more detailed description of this model and its functions is provided in Williamson et al., working paper.

Utilizing the FL TDA

Steps to utilize the FL TDA are:

a. On the Product Manager (PM) form, select the Ground Mobility product group.

b. Highlight "Facility Location" and press "Create".

c. Provide the time constraints (maximum response time) in minutes.

d. Highlight the appropriate mobility speed prediction and press "OK". If the desired prediction is not available, press "Cancel" and perform the steps necessary to create a new speed prediction. If "OK" is pressed, the user must choose between using the conventional speed overlay or using the percentile overlays. Once this selection is made and "OK" is pressed, the evaluation will begin.

e. Once the model has completed execution, use the Product Manager to display the results. An example is shown in Figure 110.

Example Scenario and TDA Walk-Through

Your organization is assisting in civilian disaster relief activities by establishing shelters within your AOP. The shelters must be reachable by most wheeled vehicles within 20 minutes, at least 90% of the time. Determine where these shelters must be located. Steps to perform this task are as follows.

a. Ensure that the desired speed prediction is available by first displaying it via the PM capabilities. If you are unfamiliar with the AOP in which you are working, it may be necessary to perform a Time Contour Analysis to gain a feel for an appropriate time constraint for the AOP.

b. On the PM form, select the Ground Mobility product group.

c. Highlight "Facility Location" and press "Create".

d. Provide the desired time constraint.

e. Highlight the appropriate mobility speed prediction and press "OK". Highlight "10th Percentile" and press "OK".

f. Once the model has completed execution, use the PM to display the results. Use the legend editing capabilities to alter the display of the selected sites and the coverage of the AOP to suffice your needs.

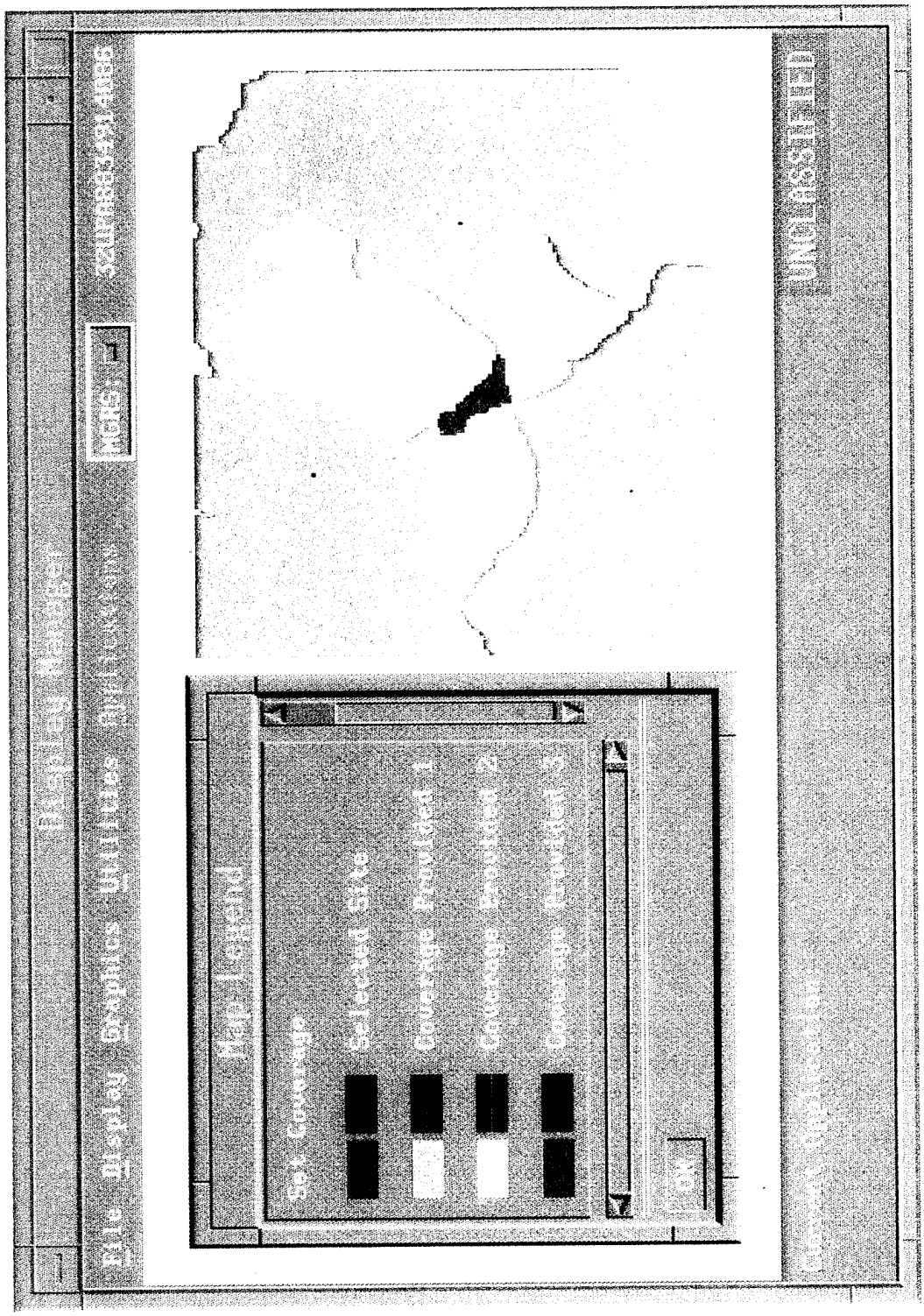

Figure 110. Sample FL TDA

18 Advanced Uses Of CAMMS-D TDAs

Introduction

CAMMS-D provides other risk-based TDAs that have no executable software associated with them. These include the Reconaissance Recommendations TDA and the Risk Assessment and are labeled as "Uncertainty Overlays" in the Product Manager.

The Reconaissance Recommendations TDA indicates patches of terrain on which the mobility model predicted a wide range of possible speeds, with the lower end of the range extending into NOGO conditions. Therefore, the user may consider these areas NOGO until a recon has proven the areas otherwise.

The Risk Assessment TDA indicates patches of terrain on which the mobility model predicted NOGO conditions even at the higher percentiles. The foundation for this involves comparing NOGO areas for various cases. For example the NOGO areas indicated from conventional and 75th percentile predictions can be compared to identify areas that may be passable for the threat although conventional analysis indicates otherwise. Thus, the areas in question are characterized as having greater than NOGO speeds at the 75th percentile (better than average case) and NOGOs at the conventional prediction. Similarly, areas that are NOGO at the 90th percentile indicate that there is a 90 percent chance, or greater, of immobilization.

Utilizing the CAMMS-D Uncertainty TDAs

The steps for utilizing these TDAs will be expressed in general terms, since no executables are associated with these TDAs. In fact, the operation and utilization of these TDAs are similar to the BTF TDAs described in Chapter 9.

From the Ground Mobility products list on the Product Manager, highlight one of the TDAs described in this Chapter. The legend editing capabilities may be used to tailor the display of these TDAs. The user will be allowed to select an overlay for display or will be provided useful information on accessing.

Example Scenario and TDA Walk-Through

One use of these TDAs is displaying them, individually, with a speed overlay. For example, perform the following.

From the Product Manager, select a conventional speed overlay and edit the legend so that only the NOGO areas within the overlay will be plotted. Use a "hashed" pattern for plotting. Now, select a 75th percentile overlay and edit the legend so that only the NOGO areas overlay will be plotted. Use solid patterns for this plot. Press "Plot". The resulting overlay will present the NOGOs in the AOP and provide an additional level of information concerning the extreme likelihood of NOGO conditions.

Figures 111 and 112 provide examples of plotting these TDAs with other overlays to provide additional information.

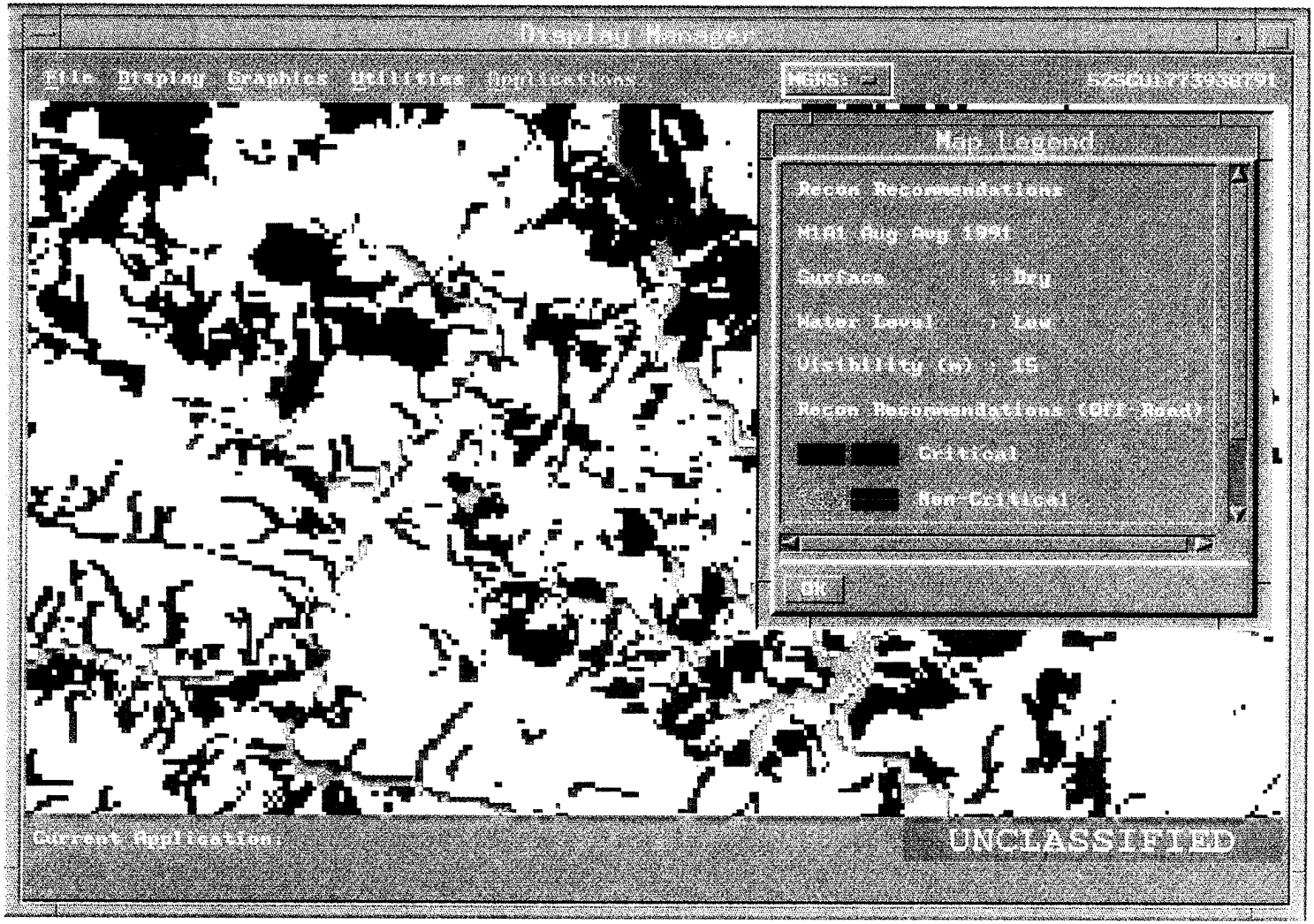

Figure 111. Sample Recon recommendation TDA

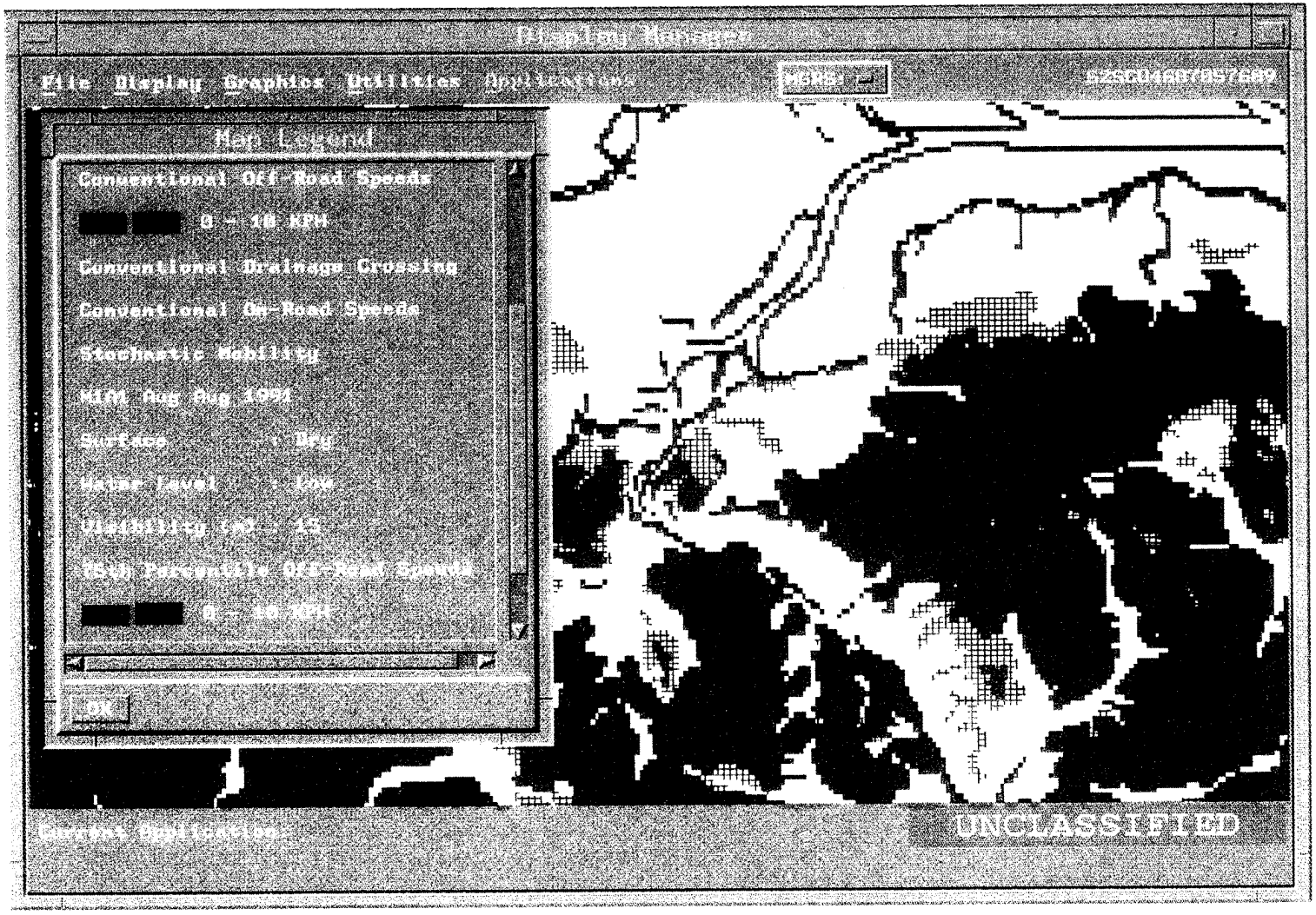

Figure 112. Sample risk assessment TDA

19 How to Get CAMMS-D Technical Support

If you have any problems installing or using the CAMMS-D software, you may contact Dr. Niki Deliman via e-mail at deliman@ex1.wes.army.mil or Mr. Jeff Williamson at williaj@ex1.wes.army.mil. If you are unable to utilize the network, you may use one of the commercial telephone numbers provided below.

Dr. Deliman	(601) 634-3369
Mr. Williamson	(601) 634-4014

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J. L. Williamson, N. C. Deliman

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13.ABSTRACT ***(Maximum 200 words)***

Conventional mobility analysis is concerned with generating a speed prediction for one vehicle or a unit of vehicles operating in specified terrain to identify areas of immobilization and derive other information, such as time associated with traversing a given route. The risk-based approach moves beyond conventional mobility analysis by factoring in uncertainties concerning actual vehicle speed to present a range of speeds. This information can be used to derive useful and insightful decision aids and to plan for best-case or worst-case scenarios. This document presents the risk-based mobility methodology, related applications, and methods for generating various products derived from this approach.

The risk-based methodology was purposefully implemented into a known platform, the Comprehensive Army Mobility Model System - Developmental (CAMMS-D), to meet the geographic information system, user-interface, and graphical display requirements for demonstration and to gain user feed-back. Consequently, a significant portion of this document is concerned with the operation of CAMMS-D.

Risk-based applications developed to provide insight for ground mobility assessments include: identification of high-probability NOGO areas, maximum and minimum arrival times associated with identified mobility corridors, time contour analysis, named areas of interest, and others.

14.SUBJECT TERMS

Facility location	Mobility corridors	Route analysis
Ground mobility	Mobility modeling	Stochastic modeling
Mobility	Named areas of interest	Time contours
Mobility analysis	Risk-based modeling	Vehicle speed

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